# POLICY SUPPORT TO ATTRACTIVE SCIENCE ENGAGEMENT FOR FEMALE TEENAGE STUDENTS

Policy paper

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Erasmus+

# CONTENT

This paper is based on 26 months of practical experimentation with the participation of five secondary schools, teachers, and students, three knowledge partners, and one quality assurance partner from different European countries.

The paper aims to explain the benefits of creating attractive science learning for teenage girls in secondary school, and how such initiatives can be supported at local and national policy-making levels.

The lessons learned are based on dialogues with the students and teachers throughout the project.
Key messages, unedited and authentic, from the participants, are inserted.

The language of the document is non-academic and the text is constituted by short and precise statements, referring to practical experience from similar projects. The goal is to make the report content accessible and attractive to very large audiences.

In other words, the text wishes to contribute to understanding what further steps should be taken in the core field addressed.
Thus, the text might inspire new European initiatives based on and going further than the project.

Rich examples of the project experience can be found on the project website

*The* Science4girls *project 2020-22 is funded by the European Commission Erasmus+ program*

## INTRODUCING THE PROJECT

*Above all, there is a need to involve citizens, young and old, as active agents at the heart of inquiry-oriented science learning in identifying and framing the research problems and leading to the discovery of solutions and innovations which help situate science in everyday life.*
*Commission, "Science Education for Responsible Citizenship", 2015*

NOTHING HAS WORKED!
THE CHALLENGE
For many years EU has tried to make science education more attractive to girls, and to encourage them to a life in science.
However, science education and science jobs are not attractive to most girls in the EU.
Several Erasmus+ have addressed this challenge; but many remain in what we can call "modernisation" of traditional science learning, including forms of "girlification".
They mostly do not basically change female students' images of science.

In 2020 we have a historic opportunity to go much deeper, to take the girls' values seriously, and start developing more fundamental changes in science learning.
This opportunity is based on three factors:

- The EU Commissions' promotion of open science schooling: OSS as the most powerful innovation of science learning, including applying a responsible science approach
- The urgency for all youth to address climate change at all educational levels

- Climate change education is now included as a priority in the Erasmus+ program

RESPONSE TO THE CHALLENGE
- Female values can be heard and integrated when working with real-life science challenges.
- Open Science Schooling offers to work critically with science to address important science challenges, and to engage in collaboration with community players.
- Learning science through climate change prevention offers opportunities to create images of science presenting them as extremely useful to life and protecting new generations from imminent disasters.

The combination of an interplay between these factors creates a more powerful innovation than the mere addition of the 3 factors.
Interviews with female students suggest that working with science in this way might change many images of science and show them how science can be of extreme value.
This approach is sufficiently radical to change the negative conclusion of joint research: NOTHING HAS WORKED.

## THE FRAME. THE 21ST CENTURY LEARNING VISION

Recent research, the European Commission, as well as considerable practical experience clearly conclude that the new generations of young students are fundamentally different from earlier generations.
They learn, think, live, and work in fundamentally different ways and the traditional education system and paradigms do not work well for these students.

After several Erasmus+ experimentations and lessons learned we can say that there are a number of key conditions for young people of today and tomorrow to engage in learning.

Let's name the most relevant conditions referring to the meaning of 21st century students:

- Learning is focused on fostering dynamic, creative and collaborative competences, not on fixed curricula and static didactics
- 21stcentury learning seeks to help learners establish their own learning ecologies, according to their needs, interests, and ambitions
- Learning seeks to organize subject learning in ways that foster state-of-the-art general competences, including the capacity to learn, address challenges, manage change and contribute to solutions
- Learning is organized as authentic real-life missions interacting with surrounding local and global communities
- 21stentury learning is designed to include and not exclude non-academic learners
- Learning processes seek to allow learners to fully unfold their talents, be it academic, artistic, or social talents
- Learning is hard fun and challenges the learners at the borders of their capacity, increasing motivation through different forms of serious gamification

- Learning processes exploit state-of-the-art networking technology and encourage learners to collaborate through those media, but are not governed by technology

- 21st century learning is increasingly allowing all learners to gain mastery of computer programing languages in playful ways, as well as offering creative and engaging ways to approach natural science

- 21st century learning acknowledges the importance of the social aspects of learning and the joy of spending time together in small communities

- Learning takes place in close interaction with the world of work

- Learning processes seek to be cross-subject and organized within the frameworks of important societal thematic

- Learning creates an entrepreneurial mentality and a sense of initiative, encouraging learners to look for new solutions and opportunities in their fields of practice

- Learners are encouraged to create their own independent projects or "businesses" along the learning processes, and if appropriate to fundraise those initiatives

- Learning processes foster learners' media creativity, expression, and subjectivity

- Learning processes include the creation of real products useful to others

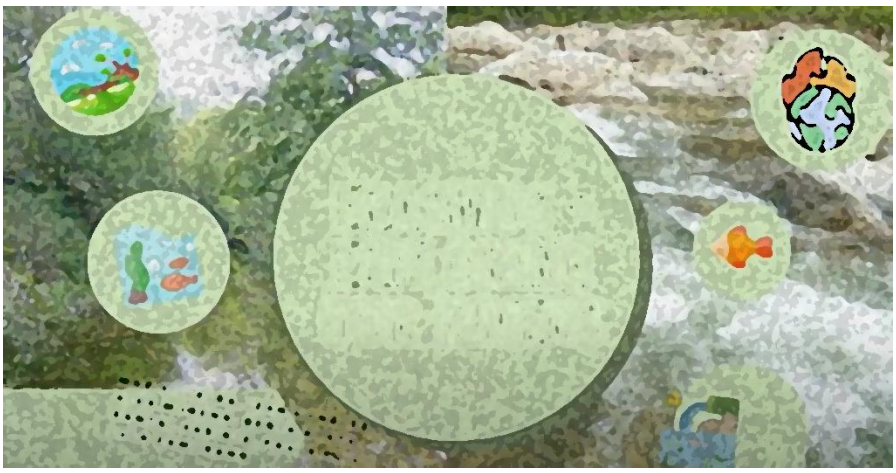
- Learning processes offer an international dimension, allowing learners to interact online and in real life with learners from other countries and cultures

- Learning projects seek to be epic and to involve the whole person in the learning process, thereby allowing learners to experience immersion

- 21st century learning allows learners to take pride in their performance and to develop realistic self-confidence, based on real-life achievements

- 21st century learning does not disregard subject learning or assessment of learners' achievements but embeds subject learning and assessment in creative and dynamic didactics

- Learning is increasingly organized as flexible communities of learning, not in the form of fixed institutions



## THE PROJECT INNOVATION

***Nothing has worked!***
*Despite more than 30 years of focus on 'enthusing, fascinating or encouraging' girls into STEM, there has been NO CHANGE in the proportion of girls choosing physics A-level. It is clear that one-off interventions don't work. Initiatives that seek to 'encourage' girls into STEM by implying that girls must change to fit into the science world are misplaced. Competitions are also a risk. Girls do not need competition to motivate them and are often more inspired by co-operative activity. And simply being a woman who works in STEM doesn't make someone an effective role model. Some role models are 'too perfect' and are therefore off-putting. For a girl, enjoying, being interested or being good at a subject isn't enough to persuade her to continue studying it – she has to be convinced that it has a value for her future and that it doesn't limit her future options.*
*"Not for people like me?" WISE, UK 2014*

Innovation engagement does not limit the learning activity to knowing about things in reality but dramatically expands the learning activity to include changing things in the realities around us.
Things that bring new ways and methods – and things cannot work well and should be improved.

Innovation interest invites the learners to interfere with how things are and to learn through impacting real life in real-time.

This represents a dramatic shift in the very basic learning principles and interacts well with the development of entrepreneurial capacity and open schooling didactics in which co-creation of change is the key.

A unanimous European policy and research community strongly recommend using co-driving and co-creation as basic principles when fostering innovation interest.

This co-creation is about the co-creation of learning, content and the acquisition of 21st century learning competences

In practice this means that the young people will need to create innovative interest, skills, and capacity through real-life and real-time and practical projects, not through classroom instruction and theoretical exercises.

In the case of gender-sensitive open science schooling, the need for co-creation of innovative didactics is double: in addition to the general need for co-creation of new ways of learning (science), we must add the specific gender-sensitive co-creation of science learning and a life in science that includes and reflects the value systems and preferences of girls and young women.

One of the valuable conclusions from gender-sensitive science learning experimentation is precisely that such missions can only be completed through the *full and uncompromised co-creation of girls themselves.*

Therefore, gender-sensitive science research and experimentation need to be based on a methodology that involves teenage girls in the full research and experimentation circles.

And the key role of research resources, schools, and teachers is to support the teenage girls' own creation of science narratives that are attractive to female students and workers.

Young female students need to develop their own science learning and science work voice.

## OPEN SCIENCE SCHOOLING - SCIENCE IN REAL LIFE

TEACHERS

Working on missions fits better on young people values because current day they are more involved in global issues and are more aware of what needs to be done to change the environment for the better.
Girls in particular are more social of the two sexes, so they would fit right in to the climate narrative.

The key challenges of OSS are getting each student to react to changes in the curriculum and adapt to circumstances presented in the middle of missions. Some students fared better than others, but as a collective they overcame the social and dynamic challenges quite well.

We believe that the meaning of "science" in our school is a way to see life

For us science in real life means the need to discover and rationalize nature, making it a friend and a tool for innovation rather than a nuisance. It also means connecting people together in various expeditions, and forming a bond with the local community in the process.

STUDENTS

The teacher proposes to do a project of the fauna & flora, the air pollution and the natural disaster and we distribution in 3 groups for each topic. It was different, interesting, not boring.

Students liked the outgoing aspect of the missions. They defined science mission as a way to interact with the community through a campaign that is backed by research and curiosity nested in scientific discovery.

The students believe and like the OSS missions' way. They said that as long as there is some rapport to the real world, the missions will have made a lasting impact on their own decision-making in the broader scheme of things.

*Engage the participating girls and their support teachers in real-life and real-time science and research experience in collaboration with the local community, including interacting with female role models in science and research.*
*The project*

Educationalists have struggled for decades to try to engage young teenage students in science education and choose a career in science.
Considerable efforts have been made, but in the end, we are forced to conclude that little has worked.

Most initiatives to make science education more attractive to teenage learners are about "modernizing" traditional science teaching: using technology, visiting science resources outside school, including some forms of gaming and entertainment, etc.

The open science schooling methodology is the first systematic attempt to fundamentally change science education for young students. Open science schooling is strongly recommended by the European Commission and leading research.

Science4girls forms part of the Commission's Science Learning Innovation Agenda, contributing through its gender-sensitive approaches to the practical experimentation of building new directions for science learning and engagement and developing attractive practical guidance for secondary schools across Europe.

The 26 months of the project experience produced lessons learned about all the obstacles such project mission met, from European funding to the work conditions of the individual teacher.

The science learning innovation takes place in a strange landscape with many extremes: on one hand, it seems that science teaching is conservative, restrictive, and traditional of all school subjects; on the other hand, the surrounding community and world offer thousands of dynamic and exciting science cases and missions.
The problem is the giant gap between these two extremes in the science education scenario.
When discussing innovation in science education, this innovation clearly goes in the direction of open schooling.

Open science schooling refers to education that works with real-life challenges in the community and globally, allowing students to learn through engaging in science challenges, problems, and innovation.
This indicates that learning is no longer linked to the classroom but to the world outside the school.
This is no less than a revolution in (science) education, and more so as open science schooling goes far beyond punctual activities outside school such as visits to a science center or similar.
The point is to take open science schooling to a level where the students accomplish something real and allows them to create fundamentally new images of science, influence science in real-life, and integrate new attitudes towards science in the development of their identities.

It is rather a new dimension in learning and schooling, offering young students immersive, continuous and community-based experience and with the clear aim to foster interest in changing things, detecting new opportunities, engaging in interesting collaboration, playing detectives and explorers – and doing all this at the same time playfully and seriously.
In this way, innovation missions and other forms of open schooling develop citizens dedicated to taking action in and improving the communities they live in.

There are, obviously, different ways of innovating science education (and education in general), but there are very strong reasons to focus the innovation on open schooling:

- ✓ Open science schooling offers teenage girls real-life experience of the diversity of science and how many different lifestyles are possible in the field of science; this might help them overcome their "science lifestyle resistance"

- ✓ It allows the girls to leave traditional, rather theoretical science instruction and work with real-life science and real people

- ✓ It allows teenage girls to work in teams and identify climate challenges in the local community, and engage deeply in those challenges

- ✓ It offers young students much more practical, realistic, and action-oriented science experience and this might help change their general resistance towards traditional and obsolete classroom science

- ✓ It offers teenage girls experiences about how science works in real life: what is science really about, what are scientists doing, etc.; this might help the girls integrate the social and ethical aspects of science which is important to teenage girls and to young women in general

- ✓ It gives the possibility to learn science through real-life science and climate change engagement, and the inserted science knowledge sessions will now appear relevant and useful to them

- ✓ It offers all young students much more realistic impressions of what science is and what scientists do; this might help many young students overcome typical negative imaging of science and scientists as well as overcome the resistance to science produced in the old classrooms

- ✓ Open science schooling can, contrary to classroom science, offer young students' deep engagement in exciting missions, some of them not much different from what they experience in advanced video games; this will re-install the feeling of "adventure" in science that was totally lost in the classrooms and be attractive to both genders of digital natives.

Immersive engagement means that the science mission should be carried out across considerable time periods – months, a semester, or an entire school year. This is why it is important to integrate science missions well into the normal life of the school.

Through collaboration with relevant community and climate change resources the students will be able to work in climate change missions designed by them, and to the extent possible accomplish the missions.

The students can create their own story-telling from the missions, helping them to create their own science and climate change voices.

- ✓ Open science schooling methodology allows students to combine local action with a global orientation, a combination incredibly important in climate change prevention

- ✓ The teachers learn side-by-side with the students and serve as facilitators and inspirators

For all these reasons open science schooling methodology has proven to be a great engager of young students not engaged in science and not finding science learning attractive.

However, is also the most demanding direction, as science learning in open schooling scenarios cannot any longer take place in the classrooms.

## FEMALE IDENTITY. HAVING A VOICE

TEACHERS

Climate change missions fit better in young people values because current day young people are more involved in global issues and are more aware of what needs to be done to change the environment for the better. Girls in particular are more social of the two sexes, so they would fit right in to the climate narrative.

The girls' voices are already being heard through various initiatives, but to bolster it even further, they must be endorsed, advertised and respected in some cases even more than their male counterparts, because it is women who are on the rise in those fields and they need that attention.

STUDENTS

We can make more diffusion about science women like Valentina Tereshkova.

*When students focus on tasks they are truly interested in and passionate about, the amount of enthusiasm, energy, and intellect that they put forth is prodigious.*
*Marc Prensky, "Education to Better their World – Unleashing the power of 21st century kids", 2016*

The dominating way to talk about science education innovation in Europe is the "modernisation" and "popularisation" approach: if we make science more entertaining, more exciting, and more popular in its language science education in school might become more attractive to the young students and in particular to the girls…

This is not the speech of the European Commission and other global players, but it is the speech of science education innovation in practice.

As we saw, the Commission discourse is about science learning based on open schooling and the co-creation of young students, in which the learning takes place in dynamic interaction with real-life science, research, and innovation resources in the community (physical as well as virtual) and with schools playing the role of "knowledge on demand and when needed".

However, and unfortunately, it seems that in practical education, in the schools, the criteria are still based on:
-Level 1: traditional science education making even more intolerable through more testing and control
-Level 2: modernised science education including more active learning involvement of the students and including interesting visits to science centers, case studies, dialogues with role models, etc, is still the usual practice.
Science education innovation in secondary schools in Europe is – at least to some extent – moving from level 1 to level 2.

-Level 3, the Commission speech, is extremely difficult and calls for considerable and long-term experimentation.

The problem is, of course, that whereas level 2 does not necessarily include fundamental didactic changes (a visit to a science center does not change the curricula or the teaching methods), level 3 fundamentally challenges traditional science education AND traditional education in general.

But why is level 2 "modernisation of science education" not enough?
Because this change might not be powerful enough to re-engage girls and young people in science learning and in a life in science!
What level 2 might accomplish is to make science education less boring and more entertaining.
That might make girls and boys happier, but it will not change their fundamental attitudes towards science education and a life in science.

This underlines the need for fundamental changes, not for superficial or short-term popular changes, because they simply don't work.

What is then powerful enough in education to change the girls' attitudes towards science education and a life in science?
What characterizes this fundamental change?
There are three key conditions:

- ✓ Identity

The first condition for engaging girls is that science education and in particular, a life in science can be integrated into the building of female identities and personalities along the teenage years.
This is a complex process that must be taken very seriously by future research and experimentation.
And, this is also why the only way for such research and experimentation is the co-creation from teenage girls.

- ✓ Didactics

The second condition is that science education needs fundamental didactic innovation: traditional science teaching in schools does not have the capacity to engage girls in science.
An open schooling approach in which girls can collaborate with real people and with real science activities and challenges is expected to be far more attractive to the girls than science in classrooms.
In this way, girls might be able to build up interest in various forms of science directions that perhaps differ from their images of science and a life in science.

- ✓ Science in society

The most basic and problematic element in the European campaigns and efforts to (re)engage girls in science education and science work is based on that girls should change their minds about science and should grow an interest in the great variety of science activities in society.
Girls should, having realised the great diversity of science and science cultures, decide to integrate science into their identity and life.

The Commission has launched several papers and research calls encouraging reflections in the science communities to bring science closer to society and to

citizens – focusing more on what citizens need and not so much on “what science would like to engage in from a purely, isolated and fascination-driven point of view”.

By opening up the doors to real-life science and climate change, the girls are strongly encouraged to develop critical views on science and interact with a variety of community resources directly or indirectly engaged in science and climate change prevention.

At the same time, the female students can create images of responsible science, discover how science and climate change affect citizens, and at some point, build the capacity to create their images of value-based science.

Open science schooling for gender-sensitive science learning implies all the lifestyle, identity, social and ethical questions typically asked by girls and young women.
Open science schooling for gender-sensitive science learning includes *critical science*.

It is also clear that this dimension of open science schooling (the critical questions to the value systems) will be driven by girls and young women, not primarily by boys and young men.

It is very important to recognize this “having a voice” in open science schooling and from the very beginning of open science schooling practices, as it brings about new perspectives in science learning, for example from “fascination” to “change” and “responsibility”.

Returning to the needed innovation in science education it now becomes clear why any gender-sensitive science education innovation needs to be based on girls’ and young women’s co-creation.
The science communities, the educational communities, and the political communities are not able to represent the female voices.
Girls and young women will need to create their own voices in science education innovation.

# CLIMATE CHANGE PREVENTION. THE ENGAGEMENT

TEACHERS

Our students engaged fairly aptly in the climate missions, they contacted the locals and asked their opinions, tried to educate them through their campaigns. The missions were engaging for them, and they were ready to go to larger lengths to experience the extent to which climate missions were relevant to their own lives.

When creating climate change interest among students the most important principle is to adjust. Students always like a reward for their work, whether it's acknowledgement or endorsement in any way, shape or form, and besides, they enjoy the quality time spent with their peers during the climate-based missions.

STUDENTS

We think that the most important thing it's the motivation, implication and to communicate of the students in the project. Also, another important thing it's search information in internet and inform us of things that we didn't know, and if its possible talk with some experts of this topics.

The students are happy to engage in the missions when there are no movement restrictions and they are free to express themselves and move around in the environment, discovering new things to do and places to be while they complete their mission's goals.

*The five major problems facing humanity in the coming century are feeding the population, the control of disease, generating sufficient energy, supplying enough water, and global climate change.*
*If it is to meet the needs of the future, school science has to develop opportunities for students to explore what it is that scientists do and why that contribution is both enduring and meaningful.*
*Osborne and Dillon, "Science education in Europe – Critical reflections", 2008*

Why is climate change prevention efficient, and why it can work as an engagement? One of the toughest resistances towards science education among teenage learners has always been and increasingly is that they do not wish to identify with the images of scientists and a life in science.

As explained, open science schooling engages the young students deeply (not superficially) in interesting and important science activities in their community.
And this is where climate change comes in – and opens up a giant door to students' re-engagement in science.

For the first time in modern history, science learning can be made incredibly attractive to teenage students – using climate change prevention as a platform for open schooling and for deep student engagement.

The urgency of climate change prevention serves as a powerful driver of students' science engagement.

Using climate change as a platform for science education offers fundamentally different images of science and of what a life in science can be, such as:
- climate change gives practical approaches to all major scientific fields and encourages cross-subject learning
- climate change strongly links science to social, political and cultural life and to society's call for responsible science and research
- climate change needs to be seriously addressed at local level, in all communities
- the local authorities have a great and increasing interest in mobilizing its young people for climate change prevention
- climate change prevention is personal, local and global at the same time, offering very many levels of learning and taking action, including the students' personal lives
- climate change offers very powerful collective and individual missions and demands local and global action and accomplishment. Climate change missions are perfect science missions.
- climate change is taken seriously by almost all community players and science resources, offering community collaborators a strong motivation for working with the student teams
- climate change education provides a bridge between science, research and knowledge on one side and the emotional life of teenagers on the other
-climate change prevention is not about theory, but about taking urgent action at all levels and learning through this engagement.

For all this and for the first-time science education becomes relevant, personal, attractive, emotional, and incredibly exciting for the young students, allowing them to integrate new science images in the forming of their identities.

In addition, it is well-known that especially female teenagers are concerned about climate change and what it will do to our planet and to our life and to the life of our children.

This means that science education based on climate change prevention offers female students in particular a new way to reconcile science and female values.

In short,
Climate change-based science learning is dramatically different from traditional, abstract science teaching because it is first of all action based.
Even more, climate change threats will increase across the next many decades, which means that young students will be able to use climate change action to meet and learn science for as long as we can forecast.
This perspective is totally linked to the great interest of the European Commission in inviting and encouraging schools to become AGENTS OF CHANGE in the community.

Climate change missions can be passed on continuously from one student team to another, meaning that climate missions can be continued at all levels, creating even strong ecosystems of climate change prevention driven by teenage learners and by schools!

And more, the climate change missions can be continued:
- in the schools (involving new teams of students and teachers)
- in the school community (the school as a change agent)
- in the local community (establishing cross-sector collaboration to take the climate change prevention missions further)
- at a global level (continuously promoting the project's messages in social and gaming networks and linking to similar initiatives in other parts of the world)

All this makes climate change-based science learning much more attractive to less academic learners and learners that sometimes drop out of school, mainly due to traditional science teaching.

Last but not least, climate change should be no less than a CARPE DIEM for national and local educational authorities wishing to re-engage more young people in science.

For policy this is a historic momentum that should not be lost: policy can, at different levels, help innovate traditional science education, engage young students in science and at the same time fight climate change.

## THE MEANING OF COMMUNITY RESOURCES, THEIR CO- RESPONSIBILITY IN RE-ENGAGING YOUNG STUDENTS IN SCIENCE LEARNING AND A LIFE IN SCIENCE

TEACHERS

It is a challenge to collaborate with each other and follow in the same way, because there's someone that always thinks differently and make us be slowly because we have to agree with everyone.

Science and climate community resources can be enforced through group study sessions with the goal of analyzing climate research and articles and applying the knowledge gained to regular classwork activity.

Community interaction in practice means co-operating in a community setting, whether local or larger-scale, like making presentations and raising awareness in the local environment.

*Future-ready students need to exercise AGENCY, in their own education and throughout life. Agency implies a sense of responsibility to participate in the world and, in so doing, to influence people, events and circumstances for the better. Agency requires the ability to frame a guiding purpose and IDENTIFY ACTIONS TO ACHIEVE A GOAL.*
*OECD, "Education 2030*

In our current society, in which digitalization and technologies transverse almost (if not all) dimensions of our everyday life, science, technology, engineering, arts and maths learning and digital competences become key factors for students to obtain good life quality. Using an electronic form to apply for a job, navigating one's own

online banking system, or making a windmill capable to pull underground water when there is no rain to sustain the crop, all of them are examples of how STEAM is needed for different dimensions of our lives, regardless of age, economic status, and place of residence.

Nevertheless, we see a worrisome trend in youth disengagement from science learning and science related careers that are translating into a serious shortage of capable individuals in the labour market in Europe.

The Science4girls was based directly on the European Commission's "Science Education for Responsible Citizenship" in which the Commission calls for science learning that involves young students in real-life science through an open schooling methodology.

Therefore, the project's experimentation involved not only the students, but also science resources in the community as strongly recommended by the Commission.

In the project "community" was understood in its widest sense: local physical community, the region, various science communities and virtual communities.
The globalised world and the 21st century students do not separate these worlds in the way the present educational systems do.
They work with the physical and virtual communities as one world, and obviously, local science engagement might very well include considerable virtual social networking.
There are no "right or wrong" communities.

And this is why the project invited the students to work in different forms of communities along their climate missions. A number of people and institutions from various forms of physical and virtual communities were involved in the students' missions.

The roles of the community are many and important in open science schooling scenarios and experimentation.
In fact, the vision is that most of the science learning is expected to take place outside the classrooms and schools and strongly linked to real-life science activities, supplemented by "learning on demand and when needed".

Open science schooling is still in its first stages in schools, and even more so in the collaborating communities.
This means that innovators, entrepreneurs and research professionals are not at all used to and geared to collaborate with schools and students along considerable time periods and not at all used to integrate student teams in their research and innovation circles.
They are used to punctual engagements only: meetings at the school, students' visits, workshops, events and similar.

And the reality is that science communities and their professionals can only develop such collaborative competences through continued practice.

These players are deeply engaged in their innovation missions, but they do not know how to handle open schooling.

Open schooling includes long-term engagement of students, students following the life circle of innovation and students going as deep as possible into the mysteries of the innovation, including its many cross-subject implications and directions.

Community collaborators need a strong outlook to see the meaning of this interaction.

Once the science communities are mobilised to work with open science schooling, the community will be able to deliver important resources to the schools and to the teachers.
Then, early science learning will become a collective mission, not simply a school responsibility.

The point is, however, that the mobilisation of the science communities requires many rounds of (accumulative) experimentation, and it doesn't happen if schools and teachers are not given the needed space to create such experimentation.

Therefore, the mobilisation of science communities for innovative science learning is depending on the resources of schools and teachers to create and drive the experimentations.

All this is closely related to how innovation in education is depending on schools, teachers and students' motivation and it means that all the players in open schooling and creating innovation interest among students must learn; the educational players as well as the innovation players, and it also means that the educational authorities should support those activities actively, and they rarely do so…
The point is, however, that the innovation players might benefit strongly from this engagement when they learn how to use long-term contact with the future generations of citizens!

To quote the simple OECD words:
*Users are being involved in earlier phases of the innovation process - already when companies are identifying opportunity areas. The innovation process is becoming user-driven.*
*OECD, New Nature of Innovation*

Obviously, this will take much experimentation and much learning among the innovation players.
In particular it will take sustained activity, creation of eco-systems of collaboration and evaluation of the innovation players' benefits.

If pioneering and experimentation are not supported locally and nationally, the education systems will lose its dynamics, its creativity and its ability to change and address new challenges and therefore the schools will not have the tools to move and build such eco-systems of open science schooling in the community.

The vision of cross-sector learning communities is increasingly undermined by sectors focusing on their own challenges and not engaging in more complex but also more profitable and benefitting cross-sector collaboration.

All major educational innovation agendas in Europe are based on and depending on cross-sector collaboration and public and private stakeholders' engagement in learning processes.

The problem is, though, that if schools are not able to move and the sector players are increasingly focused on their own challenges, then open science schooling cannot happen.
Policy-makers should revise the way they directly or indirectly undermine such vital collaboration and develop strategies for how to re-motivate and re-mobilize both sides of the open science schooling communities.

Policy-makers in particular at local and national levels should bear in mind that it is of paramount importance to mobilise the motivation, creativity and dedication of these educational and community players.

And, lastly, policy-making should support open science schooling as the adequate learning didactics of the globalised world – instead of restricting and narrowing the room to move for schools and teachers.
This includes supporting the motivation of resources from different sectors to work with the schools.

Of course, all this process needs time, and years, and the big question is: *who will fund, invest in and drive such sustained and long-term experimentation?*

## THE EPIC DIMENSION

As a result of renewed studies of the most important Commission science education innovation guidelines and recent critical science learning research, we can recognize that one of the major components in science learning innovation to be attractive to 21st century students is that science and science learning has to recover and rediscover the links to NARRATIVE and make efforts to communicate the learning in narrative forms.

These links to narrative forms includes for example: adventure, science fiction, exploration, detective work, curiosity – and the ability to take action in such narrative worlds: NARRATIVE AND EPIC AGENCY.

To change the images of science among teenage, boys and girls need to be engaged in long-term, real-life, immersive and EPIC science missions.

The opposition and separation between (natural) science and humanities in the Western societies and cultures is extremely strong, and increasing focus on quantitative subject-based measuring and testing does not help overcome this opposition.

When is about teenage girls and young women's resistance towards science we need to take it seriously that is not resistance towards working science challenges, but resistance towards "living a life in (traditional) male-dominated science communities", so to speak.

The life in science appears to many girls and young women to contradict their femininity and their female values.

The stories told among girls and young women about science describe science communities as negative, grey and unattractive.
One of the keys to re-engaging teenage girls in science is precisely to work with the girls to create alternative narratives that the girls can integrate without resistance in their identity formation.

That's exactly where the idea of "human narratives" comes into play: science is not able to create the needed alternative narratives; it needs strong support from more holistic oriented story-telling and imaging.

An important dimension in open science schooling is therefore the cross-subject engagement of teachers – and the integration of human narratives resources from the community, addressing science linked to history, art, politics and social values.

One of the valuable conclusions from gender-sensitive science learning experimentation is precisely that such missions can only be completed through the full and uncompromised co-creation of teenage girls themselves.
Any attempt to create such missions and story-telling on behalf of the girls will fail. Then “nothing will work”.

Gender-sensitive science research and experimentation therefore need to be based on a methodology that involves teenage girls in the full research and experimentation circles.

Thus, the key role of research resources, schools and teachers is to support the teenage girls’ own creation of science narratives that are attractive to female students and workers.

Young female students need to develop their own science learning and science work voice. Then, perhaps, we can move on from “nothing has worked”.

Important to highlight that in this context the basic structures of this “identity narrative” are created in the teenage years and in secondary school.
In these years their basic narrative is created, also defining them as learners: what they like, what they don’t like, what they are good at and not good at.
Some students identify with language, others with science.
What they like and how they like to learn becomes an important part of their identity, of their “identity narrative” and even of their “gender identity narrative”.

The teenage years are the most important years for students to get new ways of learning “under their skin”, as such new ways will link to their identity formation. This is the epic dimension…

Therefore, we use the term “epic” to designate these deeper levels of identity, of learning and of ways of learning.

And how can activities have a deep impact on the students:
- the new and innovative learning activities must take place at “epic” level, very different from the traditional Tayloristic organisation of the curriculum
- the new and innovative learning activities must link to and integrate into the creation of their identity, their personality and their life story

What we are saying is that the new learning activities – creating interest in and capacity to innovate – must have epic quality to have a serious and lasting impact on the young learners, their identity formation and their life prospects.

And what does epic quality mean here?
Well, it definitely means that punctual, superficial, entertainment-based activities will not work.

## POLICY SUPPORT RECOMMENDATIONS

Partners' messages to educational policy-makers

TEACHERS

Politicians have to spend some money to science learning, projects and science material.

It's important that the powerful people of the government give example and impose laws to support science learning to female teenage students.

Politicians should focus on funding and recognition of the students, but other than that, meddling in the students' work wouldn't be a benefit, because they have to have the freedom to express themselves freely on their own accord.

Policy makers should interact with the students and ask them what changes they would like to be implemented, and if they come to an agreement, it should be given consideration, and put into actual policy.

Politicians and climate change?

Just engage in discourse with the students and ask them for refreshing opinions, which they have a lot of. When it comes to climate science, it's important to analyze each side of the situation, so communicate and solve the problems together.

About climate change and to wake up the politicians we have to do strikes and talk to politicians to try to convince them, in that way they'll talk to the congress and maybe they'll do something about it.

STUDENTS

We went to the city radio to explain our project to our town, to inform them what we had done.

Local and national policy-maker should encourage girls to study science trough advertisements and science contests.

Politicians should input new laws to stop climate change and fines to people who don't collaborate to make a better and healthier world.

The students would just like some recognition for their work and people to know that what they're doing is not just for them, but for every person in the community as well, and it's worth all the marbles.

The students like the idea of open communication, and they want to reach out to other aspects of the community through the path of politics, but since they can't do it themselves, they must rely on the policymakers.

The young people want to interact with the rest of the country through their ideas, and the policy-makers would be the ones to transform those ideas into reality. The students would like to be recognized in this way.

*Schools should develop sustainable and systematic partnerships with businesses, social enterprises and NGOs rather than ad hoc links.*
*Create 'open door' policies in schools to make them accessible to their local communities; and enabling them to draw on the skills and talents of local people.*
*Budapest Agenda, "Enabling Teachers for Entrepreneurship Education"*

Let us conclude this policy paper by providing some recommendations for educational policy-making and some ideas for the schools willing to change their directions.
The recommendations at the same time show and summarize thoughts and messages from the partners.

SCHOOL'S SELF-GOVERNANCE

Policy-making should ensure increasing self-governance in schools, allowing the experimentation needed in the globalised 21st century.
Open room to move should be integrated in all educational planning and curricula.

STRONG STRATEGIC FOCUS ON TEACHER EDUCATIONS

Policy-making should focus strongly on innovation in teacher education, in particular on initial teacher education.

The young generations of teachers are not able to manage the new open schooling and entrepreneurial approaches and the Commission's educational innovation.
Dramatic changes are needed across all teacher educations, including much more practical collaboration with schools and communities.

STRONG NATIONAL COMITTMENT
Policy-making should at national level take seriously the Commission's strategic educational innovation and support the implementation of the innovation instead of undermine it.

LOCAL ENGAGEMENT
Policy-making should ensure much more local engagement from local governments.
Local governments have important roles to play in the field of open schools and cross-sector collaboration – for example supporting the creation of local eco-systems of innovation and entrepreneurial learning.

INVOLVE COMMUNITY – OPEN SCHOOLING
Policy-making should support schools at all levels to create open schooling in collaboration with relevant community stakeholders, including from the private sector.
The Commission strongly recommend educational collaboration with the private and social sectors, but very few local governments are taking action to support this.

BOTTOM-UP INITIATIVES, NO EVOLUTION
The evolution of the educational system towards open schooling and 21st century didactics will not happen.
The last two decades have clearly demonstrated this beyond reasonable doubt.
Therefore policy-making should support a bottom-up approach in which the innovation increasingly emerges from pioneer schools and teachers.
Local policy-making should support, celebrate and reward pioneer schools and teachers.

COMMISSION EVALUATION AND CRITIQUE OF NATIONAL EDUCATIONAL POLICY
The Commission should take action to evaluate and criticise national educational policy and make an effort to ensure that Commission educational innovation is followed up at national level.

## HOW TO GET HELP AND SUPPORT SCHOOLS?

Perhaps you are a school benefitting from the valuable project material. However, your school and your teachers would still like to receive some kind of extra support and help from resources with practical experience in open science schooling to create innovation interest and capacity.

The need for such process support or peer support is quite understandable and justified. In particular if it is the first time the school engages in such experimentation.

*From where can you get such support? And what sort of support is possible?*
Let's make clear that such support does not come easily: in very few countries and regions in Europe such support is available.
Typically, the school will have to find its own way.

Anyway, there are different kinds of support:

LOCAL
Typically, local support is difficult to obtain.
In some cases, the municipality is in favour of new learning activities and new opportunities for young people in the community, but that does not mean that they can provide support.
In other cases, science community resources might wish to engage and support, as open science schooling for innovation interest is linked to creating competences and science reengagement on students.
But again: interest does not mean capacity to support.

NATIONAL
If the school is lucky, they might be able to identify higher educations or research and science innovation institutions working with innovation in education and perhaps even with open schooling.
Such institutions might be interested in collaborating with a school that wishes to engage in practical experimentation.

In some cases, national educational authorities make available various forms of funding for pilot projects or different kinds of educational innovation.

If schools have strong school networks, they might try to organise a group of schools that might be able to put some pressure on the national educational authorities.

EUROPEAN
It is always difficult to get support and help for pioneer educational projects.
In particular if the school is among the first schools in the region to engage in such experimentation.

Many schools in Europe therefore end up concluding that the most efficient way to get support and help is through European resources.
Strange as it may sound, it is true for many schools.

In our context this means two forms of support and help:
-support and help through participating in European Erasmus+ projects (like Science4girls)
-support and help from the Science4girls project itself

Let's take a closer look at these opportunities:

ERASMUS+ PROJECTS
Any secondary school in Europe can join school partnerships and apply for funding in the Erasmus+ programme.
Of course, this would provide the needed support and help and engage the school in a partnership working towards the same goals.
In this way the school would also be able to finance its experimentation, at least for a 2 years period.

*At least in principle because it is not easy to find such partnerships, to write applications and to get the applications granted!*

In this case the school and the teachers' teams should as a first step focus on creating a network of schools in Europe or identifying and joining such networks.
Some help might be obtained from the National Erasmus+ Agencies or through contacts to other schools in Europe, such as the schools and partners in the Science4girls project.

It is a lot of work, but it is also the most solid way to start working with open schooling for innovation interest and to get support and help from qualified and dedicated peers.
And: students can be involved along the entire life circle of such projects, for example through mobility.

## THE PROJECT SUPPORT

Now the project is terminated but the inspirational material remains available on the project website.

This does not mean that schools cannot establish contact with the project and with the different partners.
Of course, such collaboration is not financed, but there are ways to collaborate informally and still benefitting both parties.

Let us briefly describe what kind of support and help might be obtained from the project leaders and partners:

- guidance through simple mailing
- contact to interested schools
- a workshop visit to the science4girls resource from the school's teacher team (self-financed, of course)
- consultancy along the school's experimentation from project resources (to be financed)
- support and help to join European projects

There are obviously more opportunities and they will need to be discussed and negotiated in each case and when a contact is established.

Schools are free to contact the project resources and discuss what kind of support and help might be possible.

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The science4girls *has ended, but we can still help…*