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SCIENCE GIRLS

A ScienceGirls knowledge paper:

Co-creation
and the gender-sensitive science learning innovation agenda

[Paper info]

[Photos from ScienceGirls by Working with Europe]

This text

This text is based on 2 years of practical experimentation with the participation of secondary schools, teachers and young female students from all across Europe.

The aim of the text is not to summarise or evaluate the project's accomplishments, but to paint some critical perspective landscapes fuelled by the project; *critical* as the general mentality in Europe is increasingly working against the innovation agendas promoted by the Commission.
In other words the text contributes to an understanding of what kind of further steps should be taken in the core fields addressed.

Thus the text might inspire new European initiatives based on and going further than the ScienceGirls project.

You will find practically useful guidance and other material for schools and teachers on the project website.

INTRODUCING SCIENCEGIRLS

Int: Couldn't [girls] care about fashion and science?
Boy 2: No they wouldn't, because fashion and science don't mix.
'Doing' Science versus 'Being' a Scientist, 2010 (Archer, Osborne, et al)

SCIENCE GIRLS

In the ScienceGirls application we describe the project like this:

Europe's future economy and social coherence is depending on young generations with interests, skills and capacity far beyond what is offered in the traditional educational system.
Europe needs young people deeply engaged in science, research and innovation – and based on positive and engaging experiences of what science, research and innovation is at a very early age and in early schooling.

Young people are increasingly disengaged from science learning in schools and this is causing great concern in the EU Commission and among other global players.
We call this the Commission's SCIENCE LEARNING INNOVATION AGENDA, described and documented across numerous Commission documents, research papers and guidelines.

"Our research points to the potential value of schools and science educators engaging in activities and approaches that enable teachers and students to deconstruct popular gender discourses and stereotypes."
"Balancing Acts": Elementary School Girls' Negotiations of Femininity, Achievement, and Science, 2012 (Archer et al)

The ScienceGirls project aims to contribute to the Science Learning Innovation Agenda through practical experimentation in secondary school, and guided by Commission recommendation and by guidelines from leading science learning research communities. The project aims impact on science learning in schools re-defining it's to appeal to the young generations.

Synthesizing leading research, it is clear that most girls do not feel comfortable with science education and the values and personal identities linked to science and science jobs. The problem is not a lack of intellectual capacity; the problem is at identity level.

The teenage years are precisely the most important time in life for creating identity and personality, including gender identity, and this is why resistance to science among most school girls might in fact last a lifetime: when resistance towards certain school interests is directly linked to the creation of one's identity and personality, the resistance is very difficult to overcome in later in life.

This is why ScienceGirls addresses teenage girls from 12 to 16 years old and their relations to science learning.

The project will engage the girls in 3 major challenges:

HOW WE FEEL SCIENCE
- create a more authentic understanding of science and gender in early schooling through engaging teenage girls as co-creators of this understanding, through telling the personal and collective and gender-sensitive stories about science education and about the image of science in society

SCIENCE IN REAL-LIFE
- engage the 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

VISIONS OF EARLY SCIENCE ENGAGEMENT
- invite the girls to co-create scenarios of new ways of science learning in school that will appear attractive and relevant to teenage girls and their emerging gender identities

Their teachers will learn about gender-sensitive science learning alongside the teams and support the participation of the girls', but will not hold a privileged position in the project, as a united research community clearly states that "science teachers are a part of the problem", very often practicing forms of science teaching that disfavours girls and confirms many girls' "prejudices" against science and science jobs.

The project will focus on and work through 5 overall innovative thematics, based on comprehensive preparatory reviews of recent science learning research:

CO-CREATION
IDENTITY
REAL-LIFE EXPERIENCE – OPEN SCHOOLING
MIXED REALITY COLLABORATION
AUTHENTIC VISIONS FOR ATTRACTIVE GENDER-SENSITIVE SCIENCE ENGAGEMENT

The 5 overall innovative thematics are detailed across the application and in the Attachment Pack.

The project consortium is organized accordingly: 6 secondary schools as practice partners + 1 secondary school engaged through the Catalan knowledge partner, 2 academic institutions as knowledge partners and a quality assurance partner with 15 years of EU experience.

Leading gender-sensitive science researcher Professor Louise Archer from the King's College in London has signed an agreement to collaborate with the project.

A strong and most dynamic climax in the project will be the 5 days SCIENCEGIRLS SCIENCE VISION ENCOUNTER mobility in Barcelona and Catalonia, along which the participating girls will create visions for what science learning in school could be – with a strong focus on female identity.

Key outcomes will be:

THE SCIENCEGIRLS GUIDANCE TO GENDER-SENSITIVE SCIENCE LEARNING INNOVATION IN SECONDARY SCHOOL

THE SCIENCEGIRLS 30 MINUTES VIDEO

SCENARIOS OF INNOVATIVE SCIENCE LEARNING IN SECONDARY SCHOOL – produced by the girls- teams

Policy paper: INNOVATION IN SCIENCE LEARNING IN SCHOOLS IS IMMINENT – BUT WHO WILL DRIVE?

Knowledge paper: CO-CREATION AND THE SCIENCE LEARNING INNOVATION AGENDA

PART 1
GIRLS COMING TO SCIENCE – OR SCIENCE COMING TO GIRLS?

"The role of teachers has also been highlighted, demonstrating how both explicit and implicit gendered expectations and messages are frequently communicated within classrooms"
"Balancing Acts", 2012 (Archer et al)

SCIENCE GIRLS

GENDER-SENSITIVE SCIENCE LEARNING?

In preparation of the ScienceGirls project we heard and read a lot and talked a lot about gender-sensitive science education.

So, what is gender-sensitive science education, actually?
What does "science for girls mean, really?
Is it different form "science for boys"?
Or from "science in society"?

Were all these questions answered through the ScienceGirls project?
No, not at all. In fact it is very difficult to give reliable and useful answers to these very complex questions.

However, the rich practise in many European countries allowed us to build a better understanding of in which directions we should pursue the answers and create a deeper understanding.

Good and solid knowledge always builds on dynamic and powerful questions. Let us therefore summarise the many challenges in gender-sensitive science education into a set of overarching and leading questions:

Should girls come to science of should science come to girls?

Why is gender-sensitive science education interesting at all?

What's so special about "science for girls" compared to "science for boys"?

Why is it so difficult to create gender-sensitive science learning?

Let's elaborate om these questions in the following texts:

CRITIQUE OF THE DOMINATING SCIENCE EDUCATION DISCOURSE

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.

So, it seems as in schools – in practical education – there are 3 levels:

1.
Traditional science education made even more intolerable through more testing and control

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.

3.
21st century 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".

Science education innovation in secondary schools in Europea is – at least to some extent – moving from level 1 to level 2.
Level 3 in extremely difficult and calls for considerable and long-term experimentation.

The ScienceGirls practice was expected to be located between level 2 and 3; however, the project practice was closer to level 2 than 3, and for very many good reasons.

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.

Practicing open science schooling represents no less than a revolution in science education and it will take decades to implement this innovation in sustainable ways.

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 is why the million dollar question is:

What is powerful enough in education to change the girls' attitudes towards science education and a life in science?

It is a general experience among policy-makers, experimenting schools and researchers that no matter what they have tried, "nothing has worked".
This underlines the need for **fundamental changes**, not for superficial or short-term popular changes. They don't work.

What characterises this fundamental change?

1
Identity
The first condition for engaging girls is that science education and in particular a life in science can be integrated in 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 the teenage girls.
Boys do not to the same extent share this form of resistance to science engagement.

2
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 ways 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.
Boys do indeed share this form of resistance to science engagement, as they find science teaching in school abstract, theoretical, irrelevant and unapproachable.

3
Science in society
So, the most basic and problematic element in the European campaigns and efforts to (re)engage girls in science education and science work is:
- it is based on a "girls should come to science" approach.
Girls should change their mind about science ("look, this sexy and very feminine woman is a scientist") 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 in their identity and life.
Some groups of boys share this resistance, others not.

Let's briefly comment on these fundamental change parameters:

GENDER-SENSITIVE SCIENCE LEARNING AND SCIENCE LEARNING INNOVATION

Let's make very clear that Europe has a problem with all young people when it comes about engagement in science education and a life in science:
- an increasing number of young people build various forms of resistance towards science and science jobs.

Having said that, it is obvious that the resistance among young girls is *stronger* and to some extent *different*…

Let´s summarize in popular form the most important different forms of (collective) resistance:

BOYS

- find science teaching in schools abstract, theoretical and unapproachable
- cannot integrate engagement in science teaching in their 21st century social networking life styles and learning styles
- find most science teaching completely irrelevant to their present and future lives

However, some factors tend to counter this resistance:
- some boys find science and in particular technology fascinating
- some boys are able to build science-based identities
- some boys imagine well-paid science jobs

GIRLS

- in general some girls find it easier to manage abstract and theoretical science teaching, as they are better at focusing and more "self-disciplined" than teenage boys
- in general girls are not fascinated by science and technology in the same way as boys
- girls have considerable problems integrating science engagement and a life in science in the development of their female identities and personalities (self-images)
- girls produce unlike most groups of boys collective negative imaging of people in science and lives in science
- girls tend to ask other and less fascinated questions to science than boys: how is science useful? What does science produce of value to society and citizens? Why is so much science irresponsible?

What is obvious is that both boys and girls need fundamental innovation in science teaching in schools – but to some extent *for different reasons*.
Open science schooling will strongly benefit both genders.

The biggest challenge, though, appears to be strongly gender-related: science and society.
That leads us to the most complicated element in gender-sensitive science education:

INNOVATION IN SCIENCE LEARNING AND SOCIETAL CHANGE

Why does the *girls should come to science* approach not work for the girls? Because, basically and collectively girls ask critical questions to science that will remain unanswered if "girls just come to science".

Girls and young women collectively want "science to also come to girls".

What sort of questions are the girls and the young women asking to science, according to state of the art research and to the ScienceGirls experience?

The most typical and important are:
→ are science and scientists doing a lot of things we cannot identify with?
→ is science developing things useful to society and citizens?
→ what kind of values are such science missions based on and who do such values represent?
→ to what extent are science missions based on ethical considerations?
→ why is science in general so strongly linked to a male-dominated world?
→ why are science engagements not representing female values?
→ will women in science communities need to behave and act like men?
→ how can girls and women make their values heard in science?

Girls and young women express attitudes towards science and ask questions to science that are basically and inevitably *political* in nature.

Whereas language learning or history learning might be discussed without much connection to politics, this is not the case when we approach the fields of "science should come to girls".

Because perhaps it is definitely not in the nature of science to "come to girls", and perhaps science does not have such interest.
Science at large is, as we well know, deeply embedded in the global growth economy and is in fact the key driver of the increasingly competitive and market based growth economy.

In short, and without going into the complicated history of capitalism and globalisation, it is evident that reversing the "girls should come to science" into "science should come to girls" results in a number of giant challenges:
- what does it mean that science should come to girls and what does it mean that science should change and reflect female values?

This topic is called "science and society" and 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".

Now we see the big difference between level 2 (modernising science education) and level 3 (open science schooling), as level 3 inevitably link to politics and girls and young women creating a voice in politics, research and business.

Open science schooling for gender-sensitive science learning is precisely linked to politics because it implies all the lifestyle, identity, social and ethical questions typically asked by girls and young women.
Open science schooling for gender-sensitive science learning therefore 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.

In its 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".

We can easily imagine the scope of such discussions driven by critical questions from teenage girls to for example the medical industry, the energy industry and the arms industry.

At the same time the European Commission is expressing concerns about young people's increasing disengagement from politics, democracy and European values.
In particular girls and young women are not known to be deeply engaged in politics.

Perhaps a strong gender-sensitive science agenda could be one of the ways to engage girls and young women in politics – on their own terms and conditions and with their own voices?

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 politics communities *are not able to represent the female voices*.
Girls and young women will need to create their own voices in science education innovation.

This is what we will briefly comment on now.

PART 2
Co-creation of change

"Whilst many of these interventions have been carefully and thoughtfully designed by a range of appropriate experts and practitioners, evaluative evidence indicates that even the 'best' interventions may still be resisted by pupils and/or enjoyed by those involved but make little or no difference to pupils continuing with science."
'Doing' Science versus 'Being' a Scientist, 2010 (Archer, Osborne, et al)

Building on what we developed in the text above, we would now like to comment on what such gender-sensitive science innovation co-creation it about and what it means.

WHY CO-CREATION OF CHANGE IS KEY TO SUCCESS

Creating gender-sensitive open science schooling is a special case.
Why?

Because the discourses involved are all basically male dominated.
Science is male dominated, the logics of education systems are male dominated and politics is male dominated.

The Commission and leading research in education calls for co-creation practices in education, including from early schooling.
This co-creation is about co-creation of learning, of content and of the acquisition of 21st century learning competences.

However, at innovation level co-creation is also recommended: interacting with young students along the entire circles of educational innovation to ensure the relevance of the didactics for the young students and their 21st century learning and life styles.

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.

The result of these reflections is:
- no gender-sensitive science learning and science community innovation is likely to be successful unless co-created by young girls and young woman.

As young female students in general are expected to have more radical approaches to science than most groups of male students, it follows that *young girls need to be the drivers of science education innovation*.

Without exaggerating this is a hugh challenge to education, to the science communities – and to the girls.

ScienceGirls experience, however, suggests that teenage girls are ready and willing to meet those challenges if they are allowed appropriate terms and conditions and resources.

As we shall see later in the paper, such reflections at the same time call for focused action in research, innovation and policy, including in the European funding programmes.
The globalised market economy will make sure that the needed changes will not take place unless as a result of dedicated efforts at all levels.

WHAT IS CO-CREATION IN PRACTICE?

What does co-creation mean in practice in this context?

It means that groups of teenage girls between the age of 12 and 18 must be deeply involved in any science education innovation; not in tokenistic ways, as objects of change or even worse as hostages of alibi changes, but deeply involved in the entire innovation circle.

Such involvement includes long periods of interaction, capacity building of the girls to participate actively and a lot of self-reflection from educationalists, researchers and innovators to embrace the interaction.
Professionals involved in such interaction need themselves to develop strategies to involve, interact with and benefit from the girls' co-creation.

The capacity building of the girls is crucial to success as the need for their co-creation does not necessarily mean that they have the capacity to co-create.

In short, but extremely importantly, co-creation capacity must be created, not taken for granted.

In other contexts we talk about the professionals' and the systems' ability to *deconstruct* traditional research and innovation discourses to be able to incorporate the young people's co-creation.

Such co-creation can be arranged in collaboration with schools and various forms of youth organisations, and science learning and co-creation of change should be readily integrated and combined.

Now, efforts to create such gender-sensitive science education innovation in the classroom will by definition fail:
- traditional science teaching does not allow fundamental gender-sensitive activity
- traditional science teaching does not allow the girls to create and build their own critical voices
- traditional science teaching does not allow linking to politics

- traditional science teaching does not allow interaction with real-life science communities
- traditional science teaching does not allow interaction with critical science voices and missions in society
- etc.

Traditional science teaching only allows punctual, event-based or marginal engagement in gender-sensitive science education innovation.
Also because most science teachers are males and not known to be seriously interested in change, and this is in fact one of the serious obstacles to innovation in science education.

Open science schooling provides a quite different innovation and co-creation platform:

→ girls will work independently in teams and create their own approaches
→ girls will interact with science in real life and create much more realistic and flexible images of science in research and practice
→ girls will be involved in science communities and create impressions of mentality and behaviour
→ girls will interact with critical science voices in the community
→ girls will formulate their experience and tell the stories in their own way, which will allow authentic reflection of their values and preferences
→ girls will be able along these co-creation processes to develop their own standpoints and perspectives, including linking to politics
→ girls will continuously build capacity to be subjects of science

Open science schooling is therefore much more in this context than its "classical" versions: it allows the strong combination, linking and synergy between learning science in new ways, developing new forms of experience with what science is in practice – and developing strong capacity to create a voice of their own and to co-create change.

This cocktail is very powerful and should be implemented in all research, innovation and experimentation aiming to create gender-sensitive science education.

A LEARNING REVOLUTION

Unlike various forms of science teaching "modernisation" open science schooling questions fundamental principles and practices in traditional education.
This makes open science schooling demanding, complex and in need of appropriate resources.

Open science schooling, and in particular open science schooling aiming to create gender-sensitive science learning and innovation, forms part of the general learning revolution so strongly advocated by the European Commission, the OECD, UNESCO and other leading global educational players.

What does that tell us?

It tells us that open science schooling research, innovation and practical experimentation call for dedicated frameworks and solid resources and support. Small and unfocused missions will not be able to deliver the needed knowledge and results.

It also tells us that gender-sensitive science innovation is deeply linked to and depending on this learning revolution and cannot take place outside this revolution.

This has serious consequences for the European funding mechanisms as we shall see below.

RESISTANCE AND WORKING THROUGH

The resistance that teenage girls build towards science education and in particular to a life in science happens at many levels.
The forms of resistances can be grouped as follows:

Psychological
Resistance is created among teenage girls to what we call "a life in science". Girls feel that they cannot integrate the images from science communities in the female identity they are creating along the teenage years.
They feel that their femininity will be destroyed or suppressed if they live in science.
These processes are deep and complex and call for epic counter-experience as we shall see below.

Social
Young teenage students create female value systems along their teenage years. This includes making images of social interaction and social life – as grown women, as a family and as mothers of children.
They anticipate that a life in science will conflict with the images and expectations they create.
In addition many young girls and young women state that they enjoy working with and interacting with people, and they fear that this cannot take place in most science communities.

Political
Young female students are building resistance towards a life in science because they feel that many forms of science are "problematic": they feel that science is engaged in very many things that most girls find unpleasant: such science engagements as the medical industry, the energy industry, the food industry, the space industry and the arms industry create negative feelings among very many teenage girls.

Perhaps we should note that it is never a simple question of "correcting such wrongful impressions of a life in science".
Identity development and value systems are much more complicated, and the problem is also that the images the girls create of a life in science are not that wrongful…

Moreover, girls' general capacity to better follow traditional science teaching in schools than boys is expected to slowly disappear: more and more girls will follow the boys into the digital world and into digital social lifestyles and they will slowly lose the capacity to engage seriously and self-disciplined in traditional science teaching.
At the same way the traditional "female obedience" will slowly disappear in the 21st century youth cultures.

This means that real gender-sensitive science learning cannot build on this "theoretical capacity" for a long.
The young girls might be even more dependent on open science schooling than their male peers.

The point is that resistance is built at many levels at the same time, is complex and cannot be offset by simple mechanisms or interventions.

This calls for what in other fields of human science is called "working through".

The expression “working through” indicates that some form of mental state cannot simply be corrected through knowledge or through simple stand-alone counter-experience.

New experience with science from for example open science schooling must go through several circles of full engagement to be able to penetrate into the structures of identity to build and to create trust in the new experience; enough trust to allow the integration in the developing (female) personality.

The girls must, so to speak, work through the new science experience many times to create the needed mental change and to overcome resistance.

Again, this has serious consequences for the nature of research and experimentation in the field og gender-sensitive science learning innovation: the new science experience needs to be repeated, to be long and deep enough to “get under the skin” and sufficiently qualified to allow the new experience to impact the female identities.

These reflections might serve as quality criteria for gender-sensitive science research and experimentation.

PART 3
The soul of teenage girls' science voices

"Our research points to the potential value of schools and science educators engaging in activities and approaches that enable teachers and students to deconstruct popular gender discourses and stereotypes."
"Balancing Acts": Elementary School Girls' Negotiations of Femininity, Achievement, and Science, 2012 (Archer et al)

SCIENCE GIRLS

AS CITICENS GIRLS ARE OBJECTS OF SCIENCE

AS CONSUMERS GIRLS ARE OBJECTS OF SCIENCE

IN SCIENCE TEACHING GIRLS ARE OBJECTS OF SCIENCE

IN POLITICS AND PUBLIC DEBATE GIRLS AND WOMEN ARE OBJECTS OF SCIENCE

IN SCIENCE JOBS WOMEN ARE OBJECTS OF TRADITIONAL SCIENCE COMMUNITIES

AS WOMEN THEY ARE EVEN SOMETIMES OBJECTS OF TRADITIONAL MALE BEHAVIOUR AND MENTALIY IN SCIENCE COMMUNITIES

HOW CAN GIRLS AND WOMEN BECOME SUBJECTS OF SCIENCE?

What key qualities should future ScienceGirls' "subjects of science" voices build on?

Let us summarize in 4 categories:

IDENTITY

Gender-sensitive science learning innovation needs to link closely to young female students' identity building along their teenage years.
Any innovation in the form of research and experimentation should allow long and deep open science schooling experience based on uncompromised real-life community interaction.
The co-creation from female students at secondary school level should allow the girls to integrate the experience in their female identity and in their female life expectations.
The linking to their identity formation should include capacity to become *subjects of science* based on own female values and preferences and aim to build capacity to create their own science learning and science value systems voices.
It is an important part of the identity formation to allow the girls to see themselves as females and learners able to create such voices.

LIFELONG AND LIFEWIDE

Any innovation in the form of research and experimentation should allow the girls to create such images and visions of a life in science that anticipate living and working in science communities, including allowing new visioning of the balance between and combination of science engagement and social life.
Such visioning should exploit the wide opportunities in open science schooling to engage in science interaction and reflections that include all levels: psychological, social and political.
This quality should actively include integrating a political change dimension in the female voices and the capacity to act in the science politics landscapes.

EPIC

Any innovation in the form of research and experimentation should allow epic experience: "allowing me to tell my life story coherently".
Epic experience allows for long and deep engagements that are strong enough to integrate into the personality of the young students.
The epic quality of the science experience allows the young girls to create such personal stories that can embrace engagement in science learning and a life in science.
If the science experience is not at the level of the epic it cannot be expected to have a lasting impact on the girls' personality, preferences and science life visioning.

NARRATIVES

The epic form of the experience should produce individual and collective female narratives, from which the girls can build and maintain being *subjects of science*.
The girls need to express their new science experience individually and collectively in the form of narratives created by them.
Traditional reporting and activity documentation will not do the job, as these activities do not have the epic quality to narrate the new female life experiences.
The impact of the new experience, such as through open science schooling, should precisely be given narrative form by the girls to allow solid and robust integration in their identity building.

Future science education innovation research and experimentation might use such and similar guidelines and quality criteria to assess the possible impact of the missions undertaken.

PART 4
ScienceGirls CONCLUSIONS

"I said [to my daughter] why can't you do science? She said 'oh no it's a boy thing'. They had an after school science club and she said 'I'm not going because it's all boys'. I said well you should at least go along and see if you enjoy it. She went twice and then she stopped going because it was all boys and she had no girls to talk to" (Sandra, mother of Danielle).
Professor Louise Archer, King's College London

Let us summarize the most important elements in research and experimentation in the fields of gender-sensitive science learning innovation.
We will do that through brief response to some of the questions that the ScienceGirls project set out to address:

CO-CREATION

How does the ScienceGirls experience contribute to the understanding of the nature and importance of young student's CO-CREATION when fostering interest, skills and capacity in science, research and innovation?
Co-creation from groups of young female students is *sine qua non* for any science education innovation and in particular for any gender-sensitive approach to science education.
The co-creation should include not only co-creation of learning activities and results, but also of the forms of open science schooling that will deliver the innovation.
This means that groups of young female students should be included in the *full life circles* of any serious research or experimentation aiming to build gender-sensitive science learning.

EARLY SCHOOLING

How does the ScienceGirls experience contribute to the understanding of such engagement in EARLY SCHOOLING, including relevant didactics for such engagement?
Gender-sensitive science education should focus strongly on early schooling; more specifically on the years of identity formation in the teenage years.
The nature of the resistance towards a life in science is so strong and deep that it needs to link closely to the girls' self-images and life expectations.

Superficial innovation attempts will not succeed, regardless of how popular they might be.
Therefore research, innovation and experimentation to foster genders-sensitive science learning should strongly focus on secondary school and girls from the age of 12 to 18 to make the new experience lifelong and lifewide.

OPEN SCHOOLING

How does the ScienceGirls experience contribute to the understanding of co-creation through OPEN SCHOOLING – through open collaboration with the community, including relevant sectors?
We have demonstrated along the paper that open science schooling provides science learning innovation with a very strong platform for building capacity among young female students to become *subjects of science*.
Open science schooling allows interaction with real-life science and science communities and with a variety of science players in the community, including science players with critical science voices and missions.
This also means that open science schooling allows the linking of gender-sensitive science learning to the politics of science communities – in support of girls' and young women's capacity to become *subjects of science*.

GENDER

How does the ScienceGirls experience contribute to the understanding of GENDER in the fostering of interest, skills and capacity in connection with science, research and innovation?
As explained above, girls have special needs as well as opportunities to engage in science learning innovation and to create lives in science that integrate female value systems and preferences.
It can be foreseen that female students and young women will be the most powerful drivers of science learning innovation, possibly also because they will need to link the engagement to science community politics and therefore to the empowerment of the girls to act politically.
The condition for such driving from young female students and young women is that appropriate resources are in place and that the needed research and experimentation addresses the challenges in a fully holistic way, including psychological, social and political levels.

TEACHER EDUCATION IS KEY

How does the ScienceGirls experience contribute to the understanding of the new TEACHER ROLES and teacher mentality connected to the fostering of such engagement among young (female) students?
State of the art research, ScienceGirls and similar initiatives clearly state that science teachers in general are "part of the problem".
It is less likely that the present generations of (male) science teachers will engage in gender-sensitive science learning innovation.
This calls for alternative driving of such changes, in particular from two major sources:
- the needed change should be driven by open science schooling initiatives at school, local, national and European levels and be independent of the interests of individual science teachers; the initiatives should build on community resources and engagement; open science learning initiatives should include research as well as practical experimentation and a strong combination of theory and practice
- the needed change should be driven by profound innovation in teacher education to ensure the capacity of the new generations of science teachers to create gender-sensitive open science schooling, including co-creation from young female students; science teacher students need more than other teacher students to build capacity for change and innovation; such teacher education innovation should be driven strategically by national educational authorities guided by European Commission educational policy and innovation; science teacher education should include considerable open schooling practice

RECOMMENDATIONS for European funding

'I wouldn't want to be a scientist because I don't want to find these like dead bodies and bones and … ugh! And then I wouldn't like to have big grey frizzy hair … because all scientists seem to have these caps on like bald heads and they have like [inaudible] and I don't want to look like that, I want to look beautiful' (Girl, Inner City Elementary).
'Doing' Science versus 'Being' a Scientist, 2010 (Archer, Osborne, et al)

SCIENCE GIRLS

As evidenced in this paper gender-sensitive science learning innovation and open science schooling are very complex and demanding visions and missions.
They call for considerable resources, time and funding – and, dedicated policy-making at national and European levels.

Only strategic approaches seem able to tackle these challenges, building up systematic knowledge and best practices.

Present and near future national educational policy seems unable to provide such strategic innovation: budget cuts in education, increasing focus on testing and control, more students in the classes and worst of all overloaded and restrictive curricula is the menu of most member states' policy-making.

This means that European policy-making and funding appears to be the only systematic and dedicated driver of the needed innovation in science education at long-term strategic level.

We would therefore like to conclude this short-paper with some key recommendations for European level policy-making and funding in the field of gender-sensitive science learning and open science schooling, representing the most powerful forms of science education innovation.

A STRATEGICAL APPROACH IN RESEARCH AND EDUCATIONAL POLICY NEEDED

Engaging young people and in particular young girls in science and in a life in science is a hugh challenge to Europe.

Much research, innovation and experimentation is needed to create the appropriate knowledge and best practices – and it will take a sea change, as stated by the Commission, to implement such innovation at national and local levels.

It is therefore recommended to re-power the European science learning innovation agenda with a very strong strategic focus on gender-sensitive science learning and science communities.
The focus should include all levels of science learning resistance among teenage girls, psychological, social and political, and build on uncompromised co-creation from female students.

The strategic approach should begin with the new set of funding programmes from 2020 and build strong initiatives to build capacity among young female students and young women to co-drive the needed research, experimentation and change.

Such a strategic approach should recognise, describe and analyse the key and privileged roles of gender-sensitive science education innovation at didactic, social and political levels.

THE EUROPEAN PROGRAMMES – AND AFTER 2020?

Even though science engagement is at the very top of the European Commission's list of key challenges to future and globalised Europe, there are effectively only two platforms for creating science education innovation: Horizon and Erasmus+.

In connection with the new research and innovation programme from 2020, replacing the Horizon programme, we recommend the following:
- open science schooling calls with a strong focus on in-depth gender-sensitive science learning in early schooling and across the education system
- open science schooling calls requesting strong and uncompromised co-creation methodologies involving groups of young female students in the entire research and innovation circles
- open science schooling calls investigating the connection between gender-sensitive science education and female science politics
- open science schooling calls researching how female science values can be integrated in and heard across science education and science communities
- open science communities calls investigating how science communities can deconstruct their fundamental male oriented power systems and integrate female science values and preferences linked to female identities and a life in science

All such science education calls should request open collaboration with practical experimentation initiatives and request a) co-creation methodologies, b) analysing female science value systems and c) involve science communities.

In connection with the new educational programme from 2020, replacing the problematic (see below) Erasmus+ programme, we recommend the following:
- gender-sensitive science learning innovation becomes a top priority at strategic level in the educational programmes, in particular in the school sub-programme
- the programmes allow for long-term projects (3 years) and upgraded funding in support of identity based gender-sensitive science education experimentation
- the programmes invite strong cross-sector open science schooling initiatives
- the specific calls request co-creation methodologies involving groups of young female students in the full experimentation circles
- the programmes allow initiatives experimenting with methods to create and promote female value systems in science education and science communities
- the programme invites strong and coordinated collaboration with research and innovation projects

It is furthermore recommended to consider establishing a community learning programme situated between the educational programmes and the research and innovation programme to create knowledge and best practices in the field of community based educational innovation, such as open schooling, entrepreneurial learning and innovation fostering learning.

Such a programme should not be organised into educational sectors.

[Please also refer to the Erasmus+ critique below]

STRONG STRATEGIC FOCUS ON TEACHER EDUCATION

Limited results can be expected from the present generation of science teachers. As indicated along this short-paper limited results can therefore be expected from science education innovation implemented in the present science education school communities.

Basically Europe needs new generations of science teachers with a very different orientation.
Differently trained young science teachers will be able to participate in the needed “science learning revolution”, including paying considerable attention to gender-sensitive science education and science work.

However, the creation of such new generations of science teachers requires much innovation in teacher education, at national level and supported by strong strategic European initiatives.
We therefore recommend re-powering the Commission’s science education innovation agendas and developing a specific innovation and experimentation strategy for initial and further training of science teachers.

Innovation and experimentation projects can take place in the research and innovation programme as well as in the educational programmes.
It is important to such calls to request:
- co-creation methodologies allowing close interaction with young female students
- methodologies ensuring strong links to real-life science communities
- initiatives including female science politics and gender-sensitive voices in education and in science communities

The strategic initiatives should be followed up by strong and coordinated Commission initiatives addressing the need to innovate science education curricula at national level.

SCIENCE GIRLS

KEY FOCUS POINTS FOR 2020→ RESEARCH AND GENDER-SENSITIVE SCIENCE LEARNING INNOVATION AND EXPERIMENTATION

⇒ initiatives build on co-creation from young female students; not gender-sensitive science education *for* by *with* female students

⇒ initiatives should undertake missions to make available a variety of open science schooling best practices, including female value systems

⇒ initiatives focus on in-depth knowledge creation of the relation between female identity formation and new forms of science learning

⇒ initiatives study the deeper meaning of possible female value systems linked to "a life in science"

⇒ initiatives create best practices in open science schooling that reflects female values and life expectations

⇒ initiatives allow for the integration of female science politics, including female critique of science in society

⇒ initiatives study and create best practice for the creation of female voices in science education and science communities, including how such voices can be communicated

⇒ initiatives work with science communities to create interest for and capacity to interact with female science values and social practice

⇒ initiatives interact with narrative communication forms to allow female imaging of science and a life in science

⇒ initiatives engage in restoring and renewing science as adventure, pioneering and life journeys

⇒ initiatives allow powerful and open critique of science in a "science with and for citizens" perspective

The key focus points might serve as inspiration for new gender-sensitive science education projects, in particular from 2020.

ANNEX

SCIENCEGIRLS CRITIQUE OF ERASMUS+

The following critique of Erasmus+ is based on concrete ScienceGirls experience.

The need for projects like ScienceGirls to engage in critical evaluation of the Erasmus+ programme is evidenced across this paper: pioneer schools and teachers engaging in demanding science education innovation experimentation have very few local and national support opportunities and therefore the only programme for school experimentation in Europe, Erasmus+ and what might follow from 2020, becomes extremely important for the schools.

As indicated in this paper it is difficult for schools and teachers to move and to engage in the needed experimentation.
As also indicated the European programmes is one of the few opportunities for schools and teachers to engage in educational innovation, as national funding for such activities is becoming scares.

Erasmus+ and its successors therefore become extremely important to practical educational innovation in Europe.
It is the only Commission programme for educational innovation in practice.
One single programme for changing traditional and obsolete education for the new generations of Europeans - this emphasizes the importance of the programme.

Based on the ScienceGirls experience we ask: *to what extent is the Erasmus+ programme able to create the needed support measures for schools and teachers to innovate science education?*

We wish to point to some serious weaknesses in the programme, making it difficult for schools and teachers to use the programme efficiently.

It is important to bear in mind that Erasmus+ might be the only option for most schools to raise support for the experimentation so strongly promoted by the Commission.

In this perspective many schools do not quite understand why Erasmus+, as the successor of the Lifelong Learning programme, seems to have been turned into a sort of discount programme.
This does not match the importance of the needed educational innovation, as described in this paper.

A general critique of Erasmus+ is that it has been handed over to the National Agencies.

This has led to a long line of strange and less understandable practices in the different projects, as most National Agencies seem to follow own interests and administrative principles.
Projects are increasingly oriented towards national interests, not towards European interests.
The conclusion is that the management of Erasmus+ by the National Agencies has led to a devaluation of the programme.

Several National Agencies are systematically cutting project budgets by 30-40%, making considerable co-financing necessary in the implementation.
This and other NA practices seem to threaten a basic and sacred principle in European programmes: *the independency of external expert evaluators*.
This is a serious violation of European principles and should be firmly addressed and corrected by the EACEA and the Commission.

The financial structure of Erasmus+ has been simplified compared to the Lifelong Learning programme.
This is in itself positive, but the simplifications have also resulted in considerable implementation difficulties for schools.

The difficulties are in particular to be found in two major budget areas.

School partners are now expected to implement the projects at 250 euro per month.
In some countries this amount will buy one single work day per month.
Taking into consideration the complications involved in this kind of educational innovation, such an amount can unfortunately only be regarded an insult and a lack of respect for schools and teachers.

The extremely *low funding of project implementation* is a constant frustration and demotivation for most schools.

The second major weakness is linked to mobility funding.
A project like ScienceGirls is extremely student-oriented and therefore the project's 5 days mobility event was the climax of the project – for many reasons, including the quality of the final outcomes.

However, the mobility funding is so low and the rules so inflexible that it is almost impossible for partners to bring students and teachers together.
Once again this leads to considerable co-funding from the partners, from parents – or from other sources; and it threatens the European dimension of the projects.

In general, the Erasmus budget structure is more focused on formal results than on the practice on which the results should be based.

In total, for most schools the participation in serious Erasmus+ projects requires considerable co-financing.
This is not a problem in itself. The problem is that the Erasmus+ programme is <u>not</u> a co-financing programme, unlike other European programmes.

The Erasmus+ programme has therefore placed itself between two positions:
- if the programme is supposed to be fully financed, the budget must be upgraded to meet the real challenges the projects are facing
- if the programme is a co-financing programme, this should be made very clear, and the level of co-financing should be defined

The conclusion is that considering that the Erasmus+ programme for most schools is the only way to support the Commission's educational innovation, the

programme has far too many weaknesses, in the financing as well as in the management of the programme.

This calls for considerable re-thinking when designing the Erasmus+ successor(s).

YOUNG STUDENTS TAKING OVER

In one of our co-creation projects the objective was to find out how to create innovation interest and capacity among teams of young secondary school students, aged 13-14.
The project was organised in phases in which the student teams would carry out various forms of innovation missions based on an open schooling approach.
After the first phase with innovation missions, a student team revolted: *we are not pleased with the way the teachers organised these innovation missions.*
They think like teachers and give us instructions and plan most of the activities for us.
Now that we know better what innovation missions are about, we would like to create the missions ourselves: forming the teams, designing the missions, creating the work plans, finding the resources to work with and trying to carry through the missions without instructions.
The 13-14 years old students, quite normal students actually, wished to take over. They were not pleased with the traditional teacher-thinking.
Obviously, other student teams in the project felt the same; however, this team was brave enough to put it on the table.
The teachers involved were in fact known to be quite good, open and creative.
We do not think they simply "failed", the teachers.
What happened was that they struggled to deconstruct their traditional teacher roles, educational thinking and relation to the young students – with hands tied by an increasingly rigid and restrictive educational system.
This deconstruction takes considerable time and practice – but in this case the young students did not wish to wait for this.
They wanted to take over.

SCIENCE GIRLS

ScienceGirls in Barcelona 2018

100 teenage girls from all across Europe say:

WE NEED A LIFE IN SCIENCE THAT RESPECTS FEMALE VOICES, VALUES AND LIFE EXPECTATIONS

What Marc Prensky has to say about 21st century digital natives

They do not want to be lectured to.
They want to be respected, trusted, and to have their opinions valued and count.
They want to follow their own interests and passions.
They want to create, using the tools of their time.
They want to work with their peers on group work and projects (and prevent slackers from getting a free ride).
They want to make decisions and share control.
They want to connect with their peers to express and share their opinions, in class and around the world.
They want to cooperate and compete with each other.
They want an education that is not just relevant, but *real*.

It is possible, of course, to view this list as a narcissistic or unrealistic set of expectations on the part of students. But to do so would be a big mistake. Or one might find this set of expectations incompatible with teaching the required curriculum or with getting better results on standardized tests. But that would be a wrong conclusion as well.

Marc Prensky
Teaching Digital Natives

How does this profiling match traditional science teaching, modernised science education and open science schooling?

The ScienceGirls project invites schools, teachers and science learning professionals to comment on the content of this paper and to engage in a dialogue with us about the ScienceGirls experience and about science education innovation in general.

Contacts
[Link to web page with contacts]