INNOVATION VOCABULARY

21st century students

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.

In fact, we now consider that there are a number of key conditions for young people of today and tomorrow to engage in serious (science) learning.

These conditions are:

- The learning must be relevant to the young students' life
- The learning must be carried out in narrative forms known to and appreciated by the students
- The learning must be included considerable virtual activity and interaction
- The learning must allow the young students to develop critical attitudes towards science and science in society (responsible science)

- The learning must allow the students to work independently, to accomplish something real and to make their voices heard

This is what is meant across the application when referring to 21st century students.

Agency

Global policy-makers as well as educational innovators such as Marc Prensky use the term "agency" to explain that young 21st century students need to learn through building capacity to take action: change action, entrepreneurial action, critical action, action to benefit the community, etc.

The point is that the educational set-ups and learning activities should put a very strong focus on developing the students' *capacity to such agency*.

Co-creation

Co-creation is a term linked to the modern innovation discourse: problems, solutions and designs can be co-created by for example end-users or students.

Co-creation does not mean that the ones co-creating are responsible for the final outcome, but it means that the co-creators play important roles in the creation of solutions or outcomes.

In our context co-creation is linked to the students: they will be co-creators of the project implementation as well as the project outcomes, and they will be the key drivers of critical science voices in the community.

We believe that true educational innovation cannot be created without the students being authentic co-creators of the innovation.

This is even truer now than ever: *for the simple reason that we do not really understand how the new generations learn, live and think*.

"Millennials worldwide are more similar to one another then to older generations within their nations." - *Time Magazine, 2014*

This makes co-creation in educational innovation urgent and indispensable.

Community

In the *Young students as critical science detectives'* project "community" should be 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 local science engagement might very well include considerable virtual social networking.

This is why the project invites the student teams to work in different forms of communities along the long science mission phases.

Community players

In the *Young students as critical science detectives* project a number of people and institutions from various forms of physical and virtual communities will be involved through the student teams' critical detectives' missions.
Let us provide a brief overview of the most relevant and typical players to interact with the student teams:
→ Local educational and innovation authorities
→ Science centers in the city and region
→ Research and innovation bodies
→ Various citizens' groups engaged in activities in which science plays a key role
→ The students' and science teachers' families
→ Virtual science communities linked to the students' missions
→ The young students' own social and gaming network

Critical science detectives' missions

In traditional teaching the students work with text books, artificial cases and lots of theory and abstract knowledge.
In our project, and in similar initiatives, the students learn through working with real-life science challenges and in real-time.
Students in these missions do not look at the reality around them through subjects, classrooms and texts, but engages directly in science challenges of all kinds and in close collaborations with community science resources.
This completely alters the traditional educational set-up and places moreover teachers in brand new roles: as guides, as facilitators and as critical friends to the student teams, and even as the student teams' co-learners!
Students work in teams to learn through engaging in long missions of science challenges in the various forms of communities.
The way they learn through taking action in the community is to define, create and accomplish critical science missions.

Missions are projects carried out in real-life and in collaboration with real-life science players. We use "mission" instead of "project" for several reasons:
- The term "project" was once very innovative, such as in project-based learning; however, today the term can mean everything and nothing
- The term "mission" is much stronger: it refers to strong intentions, the will to accomplish and the ability to critical engagement
- The term "mission" is used in all sorts of video games and most young people are familiar with the meaning of missions: working through levels and steps to be allowed to advance in the game and to finally accomplish

In the *Young students as critical science detectives* project the critical science missions will be guided by the project's 5 step model, detailed in relevant application sections and in the Vocabulary:
1 Detecting, mapping, interacting: local, virtual
2 Team dialogues and reflections: challenge and mission selection
3 Science learning on demand: investigations, research
4 Critical interactions with the science communities selected and with the
5 Producing and sharing in wide networks the results of the science detective mission

European science learning innovation agenda

Across the project we refer to state of the art critical science learning research as well as to the European Commission's very clear science learning innovation recommendations and guidance.

Key positions are documented in the project's quotation collection in Attachment 5A and 5B.

At the same time, we and other European players have been carrying out first experimentation with what science learning innovation and open science schooling means – and how such innovation can be implemented in secondary school.

In total we call this knowledge and experience bank and accompanying innovation strategies *The European science learning innovation agenda*.

The project forms part of and refers to this agenda.

Learning on demand

In traditional education the students are taught through the principle of "learning when scheduled". That is: learning math Tuesday from 10-12.

To the students this is definitely an abstract justification of the learning.

The learning is organised to please the education system, not support the students' learning.

"Learning on demand" totally changes the perspective: the students learn when they need to learn, when it is relevant, when they are motived, and first of all: the students learn when they need to learn *to accomplish their critical science missions*.

This form of learning is based on the students' interest, not the systems.

In the project this is called "time-outs for learning on demand".

When the students work in their critical science missions, they often get stuck: we cannot progress from this point. We need to learn something first, or in parallel. Then we can progress.

"Learning when scheduled" leads to short-term remembering, whereas "learning on demand" leads to deep sustainable learning and the capacity to act.

Obviously, schools need to learn how to organise such "learning on demand" – in collaboration with community resources. This is a part of the open science schooling experimentation.

Model of young students as critical science detectives

Among the project's final results, the Model is the most important.

It aims to offer interested schools and science teachers' realistic guidance and good practice on how to start engaging young students as critical science detectives in the communities and thereby help engage or re-engage students not attracted to science.

A core aspect of and focal point in the Model is the student teams' critical science detectives' missions, including 5 steps:

1 DETECTING, MAPPING, INTERACTING: LOCAL, VIRTUAL

- The science detectives will search the community for important and interesting activities linked to science; this will include dialogues with a wide range of community players; the local science activities might very well be linked to virtual science communities relevant to the

identified topics; it is important that this science detectives' activities include serious dialogues with citizens and in particular with the students' families

2 TEAM DIALOGUES AND REFLECTIONS: CHALLENGE AND MISSION SELECTION
- After the mapping of important science activities in the communities the student team will evaluate the findings: which science activities are interesting and challenging, and perhaps even problematic in a responsible science perspective; the student team ends up selected one or two science activities to go deep into, and based on their own interests

3 SCIENCE LEARNING ON DEMAND: INVESTIGATIONS, RESEARCH
- Now the student teams will need "learning on demand": to be able to and competent to interact with the selected science challenges, they will need to create basic learning about the science challenges to engage in; several learning on demand time-outs can be inserted along the interaction with the selected challenges, but always when the students need the learning; the student team will also engage with virtual communities to kind of look behind the scene and identify critical voices in a responsible science perspective

4 CRITICAL INTERACTIONS WITH THE SCIENCE COMMUNITIES SELECTED AND WITH THE COMMUNITIES IN GENERAL
- The student team is now ready to continue its critical science detectives activity and engage in various forms of interactions with the science challenges selected, in the local community as well as virtually and in their own social networks; the science detecting does not necessarily lead to fixed scientific standpoints or attitudes towards to what extent the science activity is "responsible science"; the aim is for the students to be able to critical analyse science and science in the community and to be able to communicate their findings to others; the students critical interaction should include re-newed dialogues with citizens and with the students' families

5 PRODUCING AND SHARING IN WIDE NETWORKS THE RESULTS OF THE SCIENCE DETECTIVE MISSIONS
- To complete the critical science detectives mission the student teams will need to produce documentation of the long process they worked through – from the first disoriented mapping to the final critical communications; the student teams can choose any form of documentation from website to video, as long as the documentation really communicates what they learned on the way; the documentation, or: the accomplishment of the critical science detectives mission, will then be shared at three levels: in the school and to the other students, to a community workshop to which the team parents are invited, and in the students' social and gaming networks

Modernization of science education

In recent years very many attempts to "modernize" science teaching has been carried out.
Such "modernizations" might be visits to science resources outside the school, punctual engagement in science activities in the community, new work forms in the class – or participation in various forms of science competitions.
A popular "modernization" is to use new technology and even digital games.
The European Commission states, however, that this is not enough.
We need to re-think the fundamentals of science education and we need to develop dramatically new ways of engaging young people in science.
This is why the Commission invites experimentation with open science schooling, and also why the project will develop a realistic and implementable Model of open science schooling.

Narrative and epic agency

As a result of renewed studies of the most important Commission science education innovation guidelines and recent critical science learning research, we recognized that one of the major components in science learning innovation was: *to be attractive to 21st century students, science and science learning should 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*.

The term indicates that young students are only likely to be re-engaged in science learning and a life in science to the extent that they can engage deeply in science topics of their own interest, follow and explore such science activities across longer time spans – and use narrative communication and story-telling to express what they experience and learn.

The term indicates that they need the narrative forms and the epic (immersive) experience to be able to act in the community and to learn through this capacity to agency.

Open science schooling

The European Commission calls for re-thinking (science) education, and open science schooling is one of the educational changes increasingly recommended by the Commission as well as by critical research.

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 the learning is no longer linked to the classroom but to the world outside the school.

Obviously, 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 centre or similar.

A key point is to take open science schooling to a level where the students accomplish something real.

Re-thinking science education

The short version of this complex concept is that it is not enough to "modernize" traditional science education, or to add new features such as project work or computer games.

The new generations of students and the new and constantly changing global reality call for fundamental re-thinking of what science education is and should be: re-thinking the very basic axioms of and the very discourse of traditional science education.

As the European Commission says, it will take a *sea change* for education in Europe to accomplish this radical and urgent mission.

Therefore, much experimentation is needed…

Science engagement methodology

The *Young students as critical science detectives* Model development builds on a triangle of methodologies. The interplay and mutual reinforcement of these methodologies will be a strong platform for the project to successfully deliver its outcomes.

The science engagement methodology answers questions about HOW the participating student teams will engage in open science schooling as critical science detectives.

Schools as agents of community change

This term comes from educational innovation studies published by the OECD.

The term indicates that to provide relevant 21st century education to young students, the schools need to practice open schooling and to assume a new role in the community: allowing young students to learn through taking real-life and critical initiatives in the community in collaboration with relevant players and stakeholders.

In this sense schools are seen as drivers of change, which is almost a revolution in the education system.

Social and gaming networks

Across the application and the descriptions of the project we refer to what we call "the students own social and gaming networks".

The reason is that most young students today – and even more so in the future – are engaged in various forms of virtual networks and platforms every day – in school and after school.

Many young students sort of live half their lives in these networks – and an increasing number of students prefer to learn through this network instead of in the old classrooms.

To a project based on open schooling and creating critical science interest among the students these networks are of *great importance* and should not be underestimated.

The social and gaming networks of the students are extremely dynamic and include social contact with peers from all over the world. The young students not only share photos and engage in team gaming in these networks, they also discuss all sort of educational and personal matters.

The social and gaming networks offer the project a wide range of useful potentials:

→ The students will be able to learn from their peers in the cloud

→ The students will be able discuss their critical science detecting with their peers in the cloud

→ The students will be able to collect cases and standpoints linked to their critical science missions from their peers in the cloud

→ The student will be able to widely disseminate the results of the project in the social and gaming networks

→ The students will in particular be able to disseminate and share their own final project product: the *I am a science detective – R U?* video

Student teams

The project will involve student teams of around 5 students each from very different countries along the entire project.
The student teams are at the centre of the project and will co-create its outcomes: innovation WITH, not TO.
In particular the student teams will be drivers of the two long critical science missions' phases.
The teams will do this through their real-life and real-time science missions.

The most important thing linked to the deep involvement of the 40-50 secondary school students is for the project to learn about the following challenges:
- In what ways are the students learning science differently through the open science schooling method?
- In what ways are *Young students as critical science detectives* creating different and fresh images among the students about science and science learning?