SCIgamer

Towards 21st century science learning

Original title: Science learning and careering 3.0
Final title: Science learning 3.0 virtual gaming demonstration platform
Short title: SCI*gamer*

This paper is a presentation of the project in the Horizon application.
For interest in the development of the project concept, please see
SCIgamer concept development.
For a brief introduction, please see
SCIgamer in brief.

A Horizon Research and Innovation initiative created by the
Stefan cel Mare University and Working with Europe

The science learner as researcher
THE SCIENCE LEARNER AS DETECTIVE
The science learner as journalist
The science learner as rapporteur
The science learner as co-creator
The science learner as explorer

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THE STORY IS THE GAME
Christian Fonnesbech

SUMMARY

SCI*gamer* is missioned to produce the Science Learning 3.0 Package, a generic demonstration model aimed to fundamentally innovate science learning in secondary school, precisely addressing science learning where resistance towards science learning is built, thus responding directly to the Commission requests.

The research and innovation SCI*gamer* project aims to:

→ research didactic parameters to increase attractiveness of science learning and to counter resistance towards science learning
→ explore attractiveness and motivation generated by virtual story-telling, serious gaming, social gaming and gamification, and their possible convergence with innovative and sustainable didactics
→ design 4 innovative science learning 3.0 missions as demonstration models
→ test the models in real-life settings in educational contexts

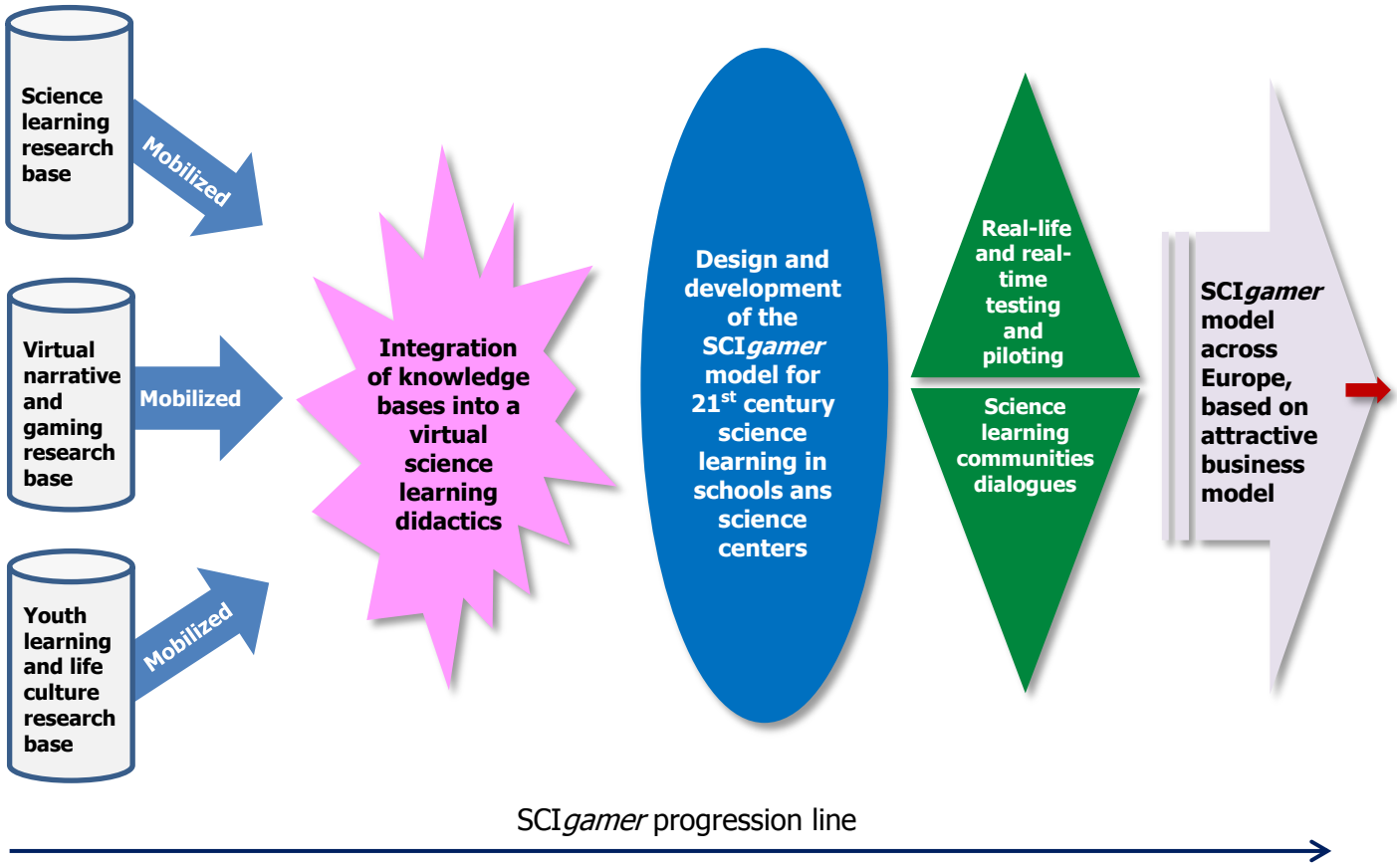
SCI*gamer* ensures specific excellence along the entire value chain of the project, from knowledge creation via virtual science innovation to the end-users. The consortium itself is extremely pan-European, cross-disciplinary and cross-sector, counting 14 partners: 6 research entities (RO, FI, DK, BE, UK), 1 innovation partner (ES), 2 virtual narrative development and production partners (ES, UK), 4 secondary schools (GR, IT, ES, PT), and 2 science centres (LT and IT).

The final outcome of SCI*gamer* is the full Science Learning 3.0 Package made up of:

→ A virtual platform designed to manage sequential and dynamic story-telling, offering clear sequential facilities and being able to receive mission material;
→ 4 science learning missions to be hosted by virtual platform and developed as close-to-real demonstrations, based on piloting with schools and science centres;
→ Platform Guide and Mission Handbook allowing external organisations engage in producing science missions

To build on SCI*gamer* results and impact, and ensure full production of the virtual narrative platform, the Consortium will create a sound business plan and ownership to the Platform.

SCI*gamer* value chain progression



The objectives of SCI*gamer*

The SCI*gamer* project proposal is a R&I action project which address the "Innovative ways to make science education and scientific careers SEAC 1-2015 attractive to young people" topic of H2020-SEAC-2015-1 Call. The project has a dual mission encompassing research and innovation as separate objectives and at the same time closely dependent one of each other. The modular structure of the project's mission ensures multiple further approaches in terms of impact. The nature of the research and innovation project is to explore various ways to exploit known and well-described attractiveness and motivation resources generated by virtual story-telling, serious gaming, social gaming and gamification.
The main objectives of SCI*gamer* project are:

Objective 1

To produce Science Learning 3.0 Package as generic demonstration model to fundamentally innovate science learning in secondary school, precisely addressing science learning at the point where resistance towards science learning and science careering is built.
Science Learning 3.0 Package is a process product based on a dynamic real-time narrative triangle, including a most interesting interaction between story-tellers and narrative editors, real-time events and learners as explorers and co-creators, aiming to make the link between creativity and science.

Objective 2

To develop innovative research in the field of science education and scientific careers and to raise awareness of the importance of trans-disciplinary research and Responsible Research and Innovation in the education system.
Science Learning 3.0 concept based on user-driven approach resulting in co-creative and continuously fed virtual eco-systems aiming at producing innovation with practically useful results, fully in line with the Commission's request for research resulting in real change for end-users and for society and bringing in the shift to innovative and effective methods.
The objective is devoted to offer the innovative research results of the project to schools and science centres across Europe after the termination of the project, aiming to impact science learning practice directly and enable young boys and girls to pursue careers in science, technology, engineering and mathematics (STEM), while at the same time adhering to the values embedded in Responsible Research and Innovation.

Objective 3

Implement a virtual platform for narrative virtual science learning space
The virtual platform must be able to receive missions, mission material, mission sequences and productions from the mission. Furthermore, the platform must offer very clear sequential facilities, manage and organize all sorts of content, and offer very strong networking spaces of well-organized user-forums. The virtual platform will perform the role of a container where immersive science learning missions can be hosted.

Objective 4

To create far-reaching impact and sustainability for the innovative results of the project and foster sustainable and cross-cutting interaction between the different levels of the education system, research institutions and other establishments, industry, Civil Society Organisations (CSOs).

Objective 5

Spread out STEM practices and better understanding of the relation between science and technology through the establishment of a link with SCIENTIX – The Community for Science Education in Europe, as well with other established European serious games and gamification communities.

Addressing the Horizon Call challenges

The SCI*gamer* project addresses the specific challenge formulated under the Horizon Call SEAC-2015-1 to bring young generations of girls and boys, as representatives of modern societies, and their reality closer to research and innovation and make them play a more active role in the Research and Innovation process, make informed choices and engage in a democratic, knowledge-based society. The project is ground breaking due to the innovative and effective methods that it proposes in order to raise the attractiveness of science education and scientific careers and boost the interest of young people in STEM, which is recommended and strongly supported by the European Commission's and the OECD's policy papers addressing the disengagement in science learning and careering.

The SCI*gamer* mission is a double one:
1. To demonstrate innovative directions for attractive science learning in secondary school – independent of possible post-project production plans, aiming to inspire future science learning
2. To offer the results of the project – the Package – to schools and science centers across Europe after the termination of the project, aiming to impact science learning practice directly

Based on the comprehensive literature studies across the last decade of science learning and careering research, including the book *Understanding Student Participation and Choice in Science and Technology Education* from 2015 (based on the European Commission supported IRIS research project), which is to be considered state of the art of what we know about students' attitudes towards science learning and resulting career choices, the SCI*gamer* team found very little systematic forward-looking science learning innovation, and even a limited number of qualified punctual science learning experiments. It is boldly and widely concluded that what we need now is science learning research linked directly to innovation and practical experimentation.
The project will not once again re-research what has across more than a decade been established as solid knowledge in Europe and globally, focusing on evidencing the decreasing interest in science learning and careering among young people and the possible reasons for this. The project will build on and mobilize this knowledge bank, move ahead and engage in forward-looking research. The project considers the following knowledge as well-established by research and policy:

- → The young generations are not demonstrating an increasing lack of interest in science, but in science education and careering
- → The main reason for this is an increasing gap and conflict between the traditional and esoteric science discourse and didactics and the life and learning styles of 21st century youth
- → Modernization will not do the job; fundamental change in the discourse of science and the way science meets young people is required
- → Dramatic changes in science attractiveness cannot take place unless strongly linked to 21st century learning forms and virtual technology, and unless involving the young people in the co-creation of the change

→ One of the keys to increase the attractiveness of science learning and careering is to bring humanities and narrative into the discourse and didactics of science, unfolding the immanent narratives of science
→ Serious games, gamification, game-like virtual exploration and narrative communicated virtual spaces, placing the young science learner as detective, explorer, journalist and researcher and allowing the creation of personal narratives, are recognized as powerful possible innovators of learning, and of science learning and sustained science interest in particular

The project will not research this, but mobilize and operationalize the knowledge for the project's future-oriented research efforts. The project will research how the increasing lack of interest, not in science but in science education, can be countered and what it will take to bring about this change through the virtual narrativization of science learning.

It is obvious that we know what is happening, even what might be the reasons, but we do not know how to approach and tackle it, and this is precisely the challenge that the project will address. The SCI*gamer* project interprets the present Call as an invitation to bring about such breaking away and to drive forward future-oriented science learning innovation and careering experimentation.

The project is designed to be followed by a major research project (2019-22) to study the actual impact of the Science learning and science careering 3.0 innovation, following a large number of secondary students (aged 12-14) across a 2 year period, and studying the what career orientations result from this innovative engagement, thus bridging from science learning research to virtual narrative based learning environment (from science learning via innovative didactics and innovative learning expertise to virtual narrative based science learning). This direct invitation is strongly supported by the European Commission's and the OECD's policy papers on the increasing disengagement in science learning and careering: bring research closer to reality, society and to change.

Nevertheless, after comprehensive literature studies across the last decade of science learning and careering research, the SCI*gamer* team found very little systematic forward-looking science learning innovation, and even a limited number of qualified punctual science learning experiments. It seems as science learning and innovation research and practice is struggling to break away from traditional paradigms and science education mind-sets. It seems that we know what is happening, even what might be the reasons, but we do not know what to do about it and this is exactly the challenge the project will address.

It seems as science learning and innovation research and practice is struggling to break away from traditional paradigms and science education mind-sets. While adhering to the values embedded in Responsible Research and Innovation, the SCI*gamer* project aims to foster sustainable and cross-cutting interaction between the different levels of the education system, research institutions and other establishments, industry, Civil Society Organisations (CSOs).

It aims at bringing both girls and boys into the scientific world via formal and informal teaching and learning and to orient them towards undertaking scientific careers. In order to be more attractive, research careers should also be more closely linked to labour market needs. As the project is locked on producing real innovation and putting this innovation to work, it has been a clear consortium strategy to include end-user partners directly in the consortium, and to include expertise in the consortium on the efficient involvement of those partners. The direct interaction with end-users (young learners between 11 and 15 and their teachers and institutions, along with open community science centres) is central to the project's innovation methodologies and to the success of the missions undertaken. Therefore the consortium counts 4 secondary schools from 4 different countries and 2 open science centres from 2 different countries, all of

them with considerable capacity and volume.

SCI*gamer* envisages 3 major research packages:

1. How do young people in secondary school imagine interesting and engaging science learning and careering? How do they imagine using explorative virtual platforms, social networking and narrative communication forms to bring about such change?

2. How can narrative-based virtual platforms, offering real-life and real-time dramatized science exploration be designed and constructed? How can such narrative science exploration be produced in the form of virtual eco-systems?

3. How can in the future science learners and teachers co-create and co-feed the virtual science exploration and how can that be developed into a future-oriented narrative science didactics?

Concept and approach

To make possible its missions, SCI*gamer* will bring together some of the most experienced, innovative and qualified resources in the fields of science learning and careering innovation and virtual narratives design, along with high-level research bodies and dedicated secondary schools.

The involved science learning researchers are international leaders in the scientific communities, highly recognized by international institutions such as the European Commission and the OECD. They have been selected on the basis of their interest and excellence in the field of bringing narrative into science learning and careering as a key tool for innovation. The cross-disciplinary consortium can work at high level along the entire value chain and prevent the traditional multiplication and overlapping of research and innovation capacity. Following the Commission' and the OECD's invitations to bring research closer to society and to real change, SCI*gamer* project has decided not to simply pool a number of higher educations, representing the same academic discourse, but to bring together all the needed players to allow the project to engage in its 21st century mission: moving from research to innovation to real change and impact.

The involved designers of explorative virtual narratives, exploiting the powerful potentials of serious gaming, gamification and a long European narrative tradition from Ulysses to Sherlock Holmes and Umberto Eco (rolled out in Peter Brooks' outstanding Reading for the Plot), are at the forefront of 21st century cross-media narration and have already carried out several successful virtual science learning and other experimentations, some of which have been heavily rewarded.

They have been selected on the basis of their excellence and of their dedication to build virtual learning and engagement on strong narrative structures. The involved research bodies have long-standing research and innovation experience in the field of science education and careering and represent state of the art research competence in Europe.

The direct interaction with end-users (young learners between 11 and 15 and their teachers and institutions, along with open community science centres) is key to the project's innovation methodologies and to the success of the missions undertaken. The collaborating secondary schools are dedicated to co-create, co-design and test the virtual science learning and careering platform produced in the project, and open to allow considerable experimentation among teachers and secondary students.

The project's evaluation and quality expert partner has long-standing European experience at all levels, including serving as evaluation expert for the Commission and National Agencies, and including collaborating with the Commission's Joint Research Centre on several occasion, in particular in connection with the Centre's research on Serious Games for Inclusion and Empowerment.

The joint partner and expert team represent the most dynamic resources possible to bring together to address the project mission and to address fundamental innovation in science learning in general.

Methodologies

This project is essentially scientific and innovative given that new knowledge is expected from it. Hence, given that the efforts devoted to innovation and implementation are relevant, we have decided to use an agile project methodology for the scientific and technical management of the project (WP1), which is well adapted to the project needs and philosophy. In particular, we propose the agile scheme specified here [AGILE], which is suitable for the coordination of the different development efforts (through the agile work-items known as stories and features), but also to model the high level scientific strategic objectives (through themes and epics).

The project work-plan is structured around the 5 themes, which basically correspond with the 5 objectives of the project introduced in Section 1.1. Each of these themes shall be split into several epics (the high-level description of problems of the end-user that the project solves). Epics are realized by features. In the agile sense, a feature means a service provided that fulfils a user's need. The features, on the side, are split into stories. Stories are low-level requirements of end-users that can be validated through specific acceptance tests. Stories will be associated to the concrete tasks from work-plan and will planned precisely (time, effort) in context of a sprint.

In our project, stories shall be executed in sprints with duration of one month. On each sprint a number of stories shall be executed and validated. Each four sprints, a release shall be generated. Releases should cover all the stories associated to a number of specific features. Features and stories are Redmine backlogs items (with priority) of the agile project queue. The research team executes and removes them from backlog following their priorities. Each 4 months, the release shall drive the generation of deliverables of the project (internal to the consortium and for EC). To enable the European Commission to execute project reviews appropriately, only the latest version of them within each project reporting period will be provided as an official deliverable requiring formal approval.

WP2 is devoted to synthesizing knowledge as state-of-the-art reports to feed into knowledge production in three main areas: A. Resistance towards science education and careering, B. Serious gaming, Narrative and digital story-telling, and C. Innovation in science learning in 21st century. The partners are grouped based on their expertise.

As it can see in Gantt diagram, WP3 is devoted to research on 3 Strands: A. Secondary school student's expectations, B. Researching didactic parameters for attractive science learning in secondary school and, C. Research on the co-creativity of young science learners and their teachers narrative science missions and continuously feed the virtual eco-systems. The conclusions and practical knowledge creation will be used to build the missions and first version of Science

Learning 3.0 Package.

In WP4, a virtual platform (technical infrastructure) shall be designed specifically to manage this kind of sequential and dynamic story-telling, independent of the various topics to implement. The virtual platform must be designed to receive such narratives as described above, including offering very clear sequential facilities, managing and organizing in missions all sorts of content, and offering very strong networking spaces of well-organized user-forums.

In short, a platform with such infrastructures that can receive missions, mission material, mission sequences and productions from the mission. The clear criterion is that the editors of the science narratives and missions should be able to create new missions and mission material without having to change the platform's technical design and infrastructures. Most ready-to-use platforms are not designed to manage this kind of narrative missions, and it is possible that the project will need to design the platform from scratch or based on useful open sources. The virtual platform is like a container in which you can insert specific narratives.

The various missions to be inserted in the platform will be designed in WP5 and concern the following dynamic elements, independent of the virtual platform and defined as content elements not as technical infrastructure:

→ design of the mission, based on real-life events
→ design of the narrative form and genre to apply
→ design of the sequential narrative structure of the mission
→ design of the position of the learning subject as for example detective, explorer or journalist
→ design of the content needed to present the first narrative sequences in the mission
→ raw design of possible narrative directions for the mission
→ managing the narrative progression including learner input
→ closing the narrative at an appropriate point

This content production must take place without needing to change the infrastructures of the platform.

The narrative design team is the story-teller who will capture real-life and real-time events with strong science learning and exploration potential, will transform the real-life raw material into a narrative and sequential based mission, will manage the continued story-telling and closes the narrative at a certain point. The narrative team is therefore active along the entire science learning process. The team will build up contacts to science resources to ensure proper consultancy as needed. This mission facilitator team can in some cases be combined with the narrative design team. The facilitator team will communicate with the learners, work in the mission forums and ensure a good flow along the missions and support learners when needed. The facilitator team might include technical capacity to control the platform infrastructures, if needed. Based on guidelines from the narrative team (or story-teller), the content production team will produce the initial and continued mission material (texts, video, graphics, animations, etc.,) and implement this content in the platform's mission section.

The ambitions

Going beyond the State-of-the-art

To generate systematic innovation, the project will not engage in what could be called gamification of already existing science education as the impact of this

would be fairly limited and punctual, nor will produce a number of small and subject-related games, as such subject-related games are already widely available. Closed and stand-alone serious digital games are limited in time and scope competition is fierce and, above all, costly because they need continuous development to bring novelty, and upgrading the challenge to feed excitement of the user. The aim of the research and innovation project is to investigate various ways to exploit known and well-described attractiveness and motivation resources generated by virtual story-telling, serious gaming, social gaming and gamification.
SCI*gamer* relies on the following assumptions that resulted from extensive review of up-to-date theoretical frameworks in the areas addressed.

Science learning research

It is established knowledge and a fact that science education in schools is creating resistance towards science learning among very many children and young people.
It is established knowledge and a fact that this resistance is particularly build up along the first years of secondary school, precisely when science learning is divided into separated subjects, and that this results in negative science career orientation at the age of 15.
It is established knowledge and a fact that this failure is caused by the extremely out-dated ways in which science is presented, promoted and transmitted in school.

Science learning innovation research

→ It is an established fact that this situation can only be changed through considerable changes in the discourse of science and through fundamental changes in the ways in which science is presented, promoted and transmitted in school
→ It is an established fact that such science learning innovation must be strongly linked to 21st century learning techniques and principles
→ It is an established fact that such science learning innovation should include systematic and creative use of technology

Science learning policy

→ It is established policy (OECD and EU Commission) that science literacy is important for all children and young people, not only for those pursuing scientific careers and that science literacy strategies have not been successful
→ There is full policy support (OECD and EU Commission) for radical change of science learning methods, didactics and science branding, including linking strongly to 21st century learning principles
→ There is full policy support for undertaking such experimentation at all levels

Serious games and gamification research

→ Consensus has long been established that that story-telling, drama and serious gaming can help innovate traditional science learning considerably
→ It is established knowledge that virtual spaces, simulations, serious gaming and gamification can increase learning motivation dramatically and can lead to inclusion and empowerment of learners – in particular in connection with less popular and often complex learning areas

Serious games and gamification policy

→ There is considerable policy support (OECD, EU Commission and Joint Research Centre) for experimenting with and applying technology supported and interactive didactics in science learning, including serious gaming and

gamification, and including experimenting with virtual spaces as organizers of science learning, not only as stand-alone events

As a result, the SCI*gamer* project sets as research scope to investigate the following:

Meta-research

→ To what extent can science learning attractiveness strategies be linked to and integrate science learning careering strategies?
→ How can traditional science learning research be replaced by innovative research strategies based on participatory research design, involving science learners in creating visions and directions for attractive science learning?
→ What could be the positive dialectic outcome of the epistemological encounter of science learning research as exploration and science learning as exploration?
→ How can dramatized or gamified virtual science learning be co-designed and co-created by secondary school students (aged 11-15)?
→ What could be the role of collaborative social networking in such co-design and co-creation?

Dramatizing science learning and careering through 21st century virtual spaces

→ How can strategic and didactic science learning and science careering attractiveness build on bringing humanities and science closer, approaching science learning in school through unfolding the inherent stories of science?
→ What is the contribution of continuous use of collaborative virtual dramatized gamified spaces to innovative science and science careering?
→ How do secondary school students imagine science learning and careering as exciting, relevant and important?
→ How do secondary school students imagine designing science learning and careering in virtual spaces, based on story-telling, drama, gaming and gamification?
→ Do boys and girls and high and low achievers imagine dramatized science learning and careering differently?
→ How can dramatized virtual spaces involve personal development routes of young people across secondary school (age 11 to 15) – from creating science interest to creating positive science careering attitudes?
→ How can a conceptual framework for designing science learning and careering from unfolding the inherent dramas of science be created, in support of the project's innovation?
→ How can a conceptual framework for linking the engagement potentials of virtual gaming, serious games and gamification to continuous science learning and careering be created, in support of the project's innovation?
→ How can the virtual platform be based on systematic continuous real-life and real-time science drama feed? How can that be organized and what kind of infrastructures would it take?
→ How can secondary students continuously co-feed and co-create real-life and real-time science dramas, including through collaborative social networking?

It is important to understand that the project is not going to develop or produce one or more serious games. Serious games are closed and topic-related systems, not easily adjustable and very expensive, as they often give priority to game parameters not necessarily important for good story-telling. In fact, the mission is not to produce a "game" in the traditional meaning of this term. Serious games cannot compete with commercial games, unless many millions of euro is invested. Intelligent story-telling can, however.

The project mission goes in a very different direction. We name this direction "Immersive virtual science exploration" (virtual narrative or virtual story-telling),

that comes close to what we plan to develop. SCIgamer wishes to replace extremely costly technology-based gaming that fascinates at first glance, but offers no epic and immersive learning, with intelligent, flexible and inexhaustible real-time and real-life exploration, in which the learner is captured by the science stories and not fascinated by the game graphics.

This interpretation puts the focus on the human narrative factor, not on costly and fascinating technology. Evidently this interpretation has serious consequences for the definition of the platform, the demonstration model, what full production means – and the kind of technology needed to support the platform and the story-telling. Whereas the serious game offers a static universe, this model offers a highly dynamic and ever changing universe in which science stories can work in all sorts of directions.

As Christian Fonnesbech, one of the virtual narrative experts in the SCI*gamer* project says "The story is the game" which became the red thread guiding the project researchers through this quest for innovative science learning. SCI*gamer* relies and forwards immersive virtual science exploration as main feature of the demonstration models. Science Learning 3.0 Package could be described as follows:

→ it offers virtual science stories, challenges and plots to follow and engage in for longer periods of time, not weeks but months, allowing the story to develop step-by-step, to diverge and allowing learners to deeply engage in such epic science stories

→ the science stories link strongly to existing or emerging real-life events, from which great science exploration can be created

→ the stories and challenges are organized in the narrative form of detective stories or like the old science exploration stories: the learners are presented to challenges, problems, strange events or similar, and they will need to start investigating the "crime scene", its backgrounds and its possible impacts

→ the stories develop over time: for example in the form of new virtual input once a week, or once a day – always in real-time, meaning that the learners will have to follow the stories as they happen, so to speak (or go back and catch up, but in this case without the dynamics of real-time exploration

→ this means that not all material will be available from the start of the science mission, as the story will unfold over a longer time period, in sequences, chapters or whatever; surprises can be expected along such real-time story-telling; it also means that someone will continuously feed new content to the platform and the story, and this is why we cannot talk about a "full production": it is more like a TV series with new events every week, but of course unlike to TV series far more interactive!

→ the learners will work in open detective forms in the platform, helping each other or challenging each other, or competing to dig deeper into the complicated events

→ the virtual narratives are NEVER simply descriptive: just delivering interesting material for exploration; the virtual narratives are ALWAYS organized as plots, mysteries and detective stories, offering a clear MISSION to the learners and to the efforts

→ this includes the continuous involvement of authoring, story design and narration, which is precisely what makes those narratives much more dynamic and interesting than close games (unless we are talking about million dollar games); and this is why our productions are never full

productions, but well-equipped platforms delivering the basic infrastructures, but requiring continuous authoring and editing

→ the virtual narratives are mission-based: the real-life material is narrated into clear quests, missions and challenges which precisely provides the needed sense of gamification without being a game in the traditional sense

→ the process aspect is therefore far more at the centre of such resources than the product aspect, fully in line with forward looking dynamic and flexible learning environments

→ the approach is therefore based on a dynamic real-time narrative triangle, including a most interesting interaction between story-tellers and narrative editors, real-time events and learners as explorers and co-creators

→ such science stories can be open-ended or close-ended, putting a strong focus on the open-ended narration, as the outcomes of real-time events cannot be foreseen and can take many different directions: the important thing is not the end of the story but the exploration itself

→ the perspective is obvious and very strong, but also very innovative: stronger learner co-creation of narratives indicating a highly dynamic take-up of real-time events with scientific interest through narrating this raw material into an interaction between story-editor and story detectives

→ in short, this approach puts a strong focus on the quality of human story-telling and less focus on technology fascinating, contrary to most commercial and serious games in which the narrative quality is replaced by technology fascination

→ the key role of the educators and other learning facilitators is to link the exploration of the learners to the science knowledging needed to work on the missions

The innovation potential of SCI*gamer*

The SCI*gamer* project will build fresh and innovative perspectives into its concept and virtual platform through students' co-feed and co-creation of real-life and real-time science narratives. Science learning must change; research in science learning must also change. Research is not independent of its object; it is involved in its object. Even if this epistemological awareness has long been established, it is mostly forgotten.

Since Law's After Method an increasing consensus is created among social researchers that no single method can account for establishing the needed knowledge: social science, including educational and youth culture research, will need to rely on mixed methods, obtaining from a variety of sources and trading the illusion of accuracy for useful insight. This is why such expressions as co-creation of knowledge and knowledge brokering have entered the scene of social research and beyond. Expressions like "negotiating knowledge" might sound terrifying to especially science researchers; however – and beyond its more populist use – these are signs of an on-going deconstruction of what science and research means.

We are witnessing the secularization of research, and this will strongly impact the SCI*gamer* approaches. At the same time, from another position, the European Commission calls for innovation in research, such as bringing research closer to society, involving end users and even inviting the former "objects" of research to co-design and interact with research processes.

Old research paradigms are falling; its objects are becoming subjects of research. SCI*gamer* relies on the established qualitative and quantitative research, on which the project is based and that constitutes the point of departure of the project research. As to research in the fields of science education, how youth develops attitudes towards science and science careers, and how this can be changed, still more researchers make the point that qualitative research across longer time spans and in close and on-going interaction with the "researched learners" are needed to understand how the resistance towards science education in schools and is created and how this can be changed.

The very innovation of SCI*gamer* project consists in combining exciting science learning in secondary with science careering preferences into one unique concept envisaged by the Science Learning 3.0 Package that will allow the young science learners to engage across longer time spans reaching up to 3-4 months (?). This means that we are talking about another kind of "science gaming", in fact not really "gaming" in the classical meaning of digital gaming, but exploration with game-like principles and building on powerful digital game mechanics.

As Marc Prensky rightly underlined in Students as Designers and Creators of Educational Computer Games (2007), producing a science game would not in any way have an impact on the young people who are not interested in the stuff produced by grownups being unable to understand the their minds. They need to be empowered to make decisions and take action which is fully answered by the project demonstration models bringing forward co-creation and feed as of extreme importance. This might be exactly what generations of young students are expecting to happen but which has not been addressed sufficiently so far. This might be the spark that will light the fire of science and that will lead them to undertake science careers at a later stage of their development.

The research and innovation the SCI*gamer* project aims to:

1. research on didactic parameters to increase attractiveness of science learning in secondary school and to counter resistance towards science learning
2. explore attractiveness and motivation generated by virtual story-telling, serious gaming, social gaming and gamification, and their convergence with innovative and sustainable didactics
3. design 4 innovative science learning 3.0 missions as demonstration models
4. test the demonstration models in relevant real-life settings in formal and non-formal educational contexts

The clear aim of the project is not full productions, but a platform ready to be used for full productions. The demonstration model to develop and produce must be of such a nature that it can serve as platform for the post-project exploitation and full productions.

The final outcome of the SCI*gamer* project is the full Science Learning 3.0 Package made up of:

1.
A virtual platform designed to manage sequential and dynamic story-telling, offering clear sequential facilities and being able to receive mission material. This is the project's live show-case.

2.
Four science learning missions to be hosted by virtual platform and developed as close-to-real demonstrations, based on piloting with schools and science centres;

3.
Platform Guide and Mission Handbook allowing external organizations to take over the production of missions, including concepts, didactic guidance, technical guidance and facilitation of the science learning process, and in particular including detailed guidance on how to create such science narratives and how to embed them in a virtual science learning platform.

4.
Exploitation Guide ensuring support for interested science learning institutions and stakeholders who will be able to start working with the 3.0 solutions right away, since the project will offer its virtual platform for others to create their science narratives and science learning processes.

5.
The Business Plan of the Science Learning 3.0 Package will offer:

→ terms and conditions for project platform use
→ development of the terms and conditions for post-project facilitation
→ guidelines on the creation of narrative science scenarios in national languages, including storyline and didactic set-up
→ guidelines on the creation of virtual material covering the narrative science scenarios, including what kind of resources this would take, and how such resources might be mobilized
→ teacher support to build capacity to lead creation of science narratives and to put the virtual space into practical operation (pedagogical and didactical training)

The project will offer substantial results and contribution, beyond what most research and innovation projects are able to offer.

The main innovation criteria for the immersive virtual narrative missions are the following:

1.
The virtual science space must allow secondary school science learners and their teachers to continuously immerse into authentic exploration of key scientific challenges

2.
The virtual science space must offer real-life and to the extent possible real-time scientific challenges, from which science learning can take place

3.
The virtual science space should not try to replace science learning in secondary school, but should offer a parallel and independent space ready to integrate in the science learning process at different levels

4.
The virtual science space must build on a strong and uncompromised narrative approach: science learning is presented through extracting and unfolding real-life science stories from which science learning can unfold: from the stories of science to science learning and back to the stories of science; narrative as the communication form of science learning

5.
Extracting and unfolding the narratives of science itself includes a strong journalistic practice, governing the entire virtual space: the space editors as journalists, the teachers as journalists and the science learners as journalists

6.
The virtual science space must engage the science learners as science detectives: exploring what happened, putting the pieces together in often sinister and complicated plots, identifying the needed science recourses on the way (internet

and community) and reporting their open ended findings in collaborative networks (the communicative dimension)

7.
The virtual science space must integrate science interest and science careering through offering long-term connectivity to the virtual space: the science learner must be able to work in an individual log and portfolio based room in the space, along with participating in the open virtual space's collaborative rooms

8.
The virtual science space must not only deliver authentic real-life challenges to explore, but also personal real-life challenges about scientists at work, allowing the learners to build up a strong understanding of "science detective careering" as science careering

9.
The virtual science space must offer the young people an open collaborative space, allowing all sorts of network and game based social communication to integrate, not limiting social networking to the rooms of the virtual space itself

10.
The virtual science space is based on a platform structure allowing various content and content forms to be inserted and structured ("plotted") and various actions to be taken; the professional game designers will define this platform structure; the structure must be continuously fed by platform editors

11.
The feeding of the virtual platform is a key challenge in the project research and design. Research should also address the extent and the ways teachers and learners can co-create and feed the platform with real-life science narratives, as well as the extent this can constitute a part of the learning

12.
The content of the virtual space should be cross-media: various forms of materials, including video, sound files, documents, photos, internet links to newspapers and news broadcasting should be combined into packages of the science narratives to open up, explore, learn from and report on – the use of media should follow the nature of the science drama or story, and in some cases the challenge and the story might be revealed step by step along the progressive detective work of the learners

13.
The real-life science dramas should allow working with the challenges at a number of levels, such as for example 3 levels, allowing for different investments in the dramas: however, all science dramas should allow for long-term, in-depths and immersive exploration and "research", and should include a limited number well-defined parameters such as history, logic, context and science people; the parameters must include building up strong experiences and images of science careering

14.
A typical science drama plot could, in simplified form, look like:

→ Encountering the challenge, getting into the drama
→ Perhaps the drama is revealed step by step, for example as a consequence of a real-life and real-time drama
→ Researching the drama through resources
→ Identifying the problem or the conflict
→ Detecting the background to and the elements of the drama
→ Creating and finding the needed resources to work through the problem including the needed science knowledge; science "learning" when needed
→ Finding evidence and putting it together
→ Teaming up with peers online
→ Creating different solutions or ways out or assessing dead-ends (new challenge to feed in)

→ Reporting the detecting and exploration collaboratively
→ Interacting with the findings of peers, in the school, in the city in another country

15.
The virtual science space must allow the young science learner to build up experience, results and career knowledge in a personal room, and to do this, working through various science dramas, continuously along a 3-4 year period

16.
The research in the project should explore the eco-system of this virtual space, including platform design, science drama editing, feeding of the virtual space, real-time facilitation of the science drama exploration, co-creation and co-feed from teachers and students: technical and economic solutions focusing on the narrative dynamics and the learners' exploration and immersion

17.
The virtual science space is characterized by openness, flexibility, changeability, co-creation of knowledge, exploiting all sorts of existing virtual resources – in short by 21st century learning, and by an increasing focus on the content co-creation and knowledge brokering of learners

18.
The science drama challenges can be constructed as missions and levels (sub-missions), and this will bring the exploration and detecting closer to the concept of a serious game; however, and if so, this should be built into the basic design of the virtual platform and its structures

19.
The virtual science space will, following these criteria, offer a new and dynamic way of searching the internet, detecting useful resources when needed, and organizing otherwise useless science information into meaningful narratives and dramas – in should be part of the eco-system of the virtual space to exploit available online resources as far as possible, but at the same time readily link to community resources in a mixed-reality approach: local resources can play as important a role in the detecting as online resources, which normally do not happen in stand-alone serious games

20.
Not being a computer game or on online game, not being a serious game and not being a gamified classroom, the virtual space is much more characterized by being a dramatic virtual science didactics, delivering a fundamental different way of science learning and interest than classroom teaching

Anticipating the New Forms of Science Learner Engagement: Attractive Student Engagement in the Project Research

Form and content are interacting. Subject and object are interacting. Research and its objects are interacting. Therefore also innovative research will need to interact with the researched. This means that the young learners collaborating with the project should be engaged in the project research through playing the roles of co-researchers, explorers, detectives and journalists – participating in the quest for new ways of science learning and how virtual narratives can help bring that about. The young science learners must anticipate in the quest for new science learning what new science learning will feel like.

The project's research collaboration with the groups of young science learners will therefore be designed along the very same principles that the project will invest in the innovative narrative virtual science learning spaces. The young learners' in-project involvement in and immersion into the quest for innovative science learning will serve as an allegory of their future engagement in the virtual space, thus endowing the project research with highly authentic reactions from the young learners – reactions that will be researched along the collaboration, and that will serve as testimonies of the engagement potential of

the future narrative virtual space.

SCI*gamer* will be the first European research initiative basing its research methodology on such authentic research interaction and knowledge brokering with the future users of its innovation. This choice of innovate methodology is deeply linked to the mission of the project, bringing about radical new forms of science engagement – and thus representing a strong break-away from the traditional and anti-innovative subject-object research paradigm.

Consortium capacity

The 3 groups of partners cover the competence and capacity needs of the consortium through offering the following expertise:

Key top drivers of science learning and attractiveness research and innovation ["key drivers"] include:

Science learning research and innovation expertise

The involved partners will provide:
→ State of the art research and knowledge on the increasing resistance to science learning and careering among young people
→ State of the art research and knowledge on the most important reasons for this resistance
→ Critical knowledge on the limitations of traditional and science learning 2.0 strategies
→ Specific research and knowledge on resistance towards science as a result of the shift from holistic science education in primary school to subject-based science learning in secondary school (pupils aged 12-15), including specific gender patterns observed
→ State of the art research and knowledge on the "image of science" among 21st century youth
→ Innovative design of a 21st century science learning discourse
→ Co-design of narrative based virtual science learning spaces
This competence and capacity role is excellently covered by:
Stefan cel Mare University - Faculty of Electrical Engineering and Computer Science (Key top driver)
Centre for Science Education Research Helsinki University (Key top driver)
Jonathan Osbourne - International science learning expert (Key consultant)

Virtual narrative development and production expertise

The involved partners will provide:
→ State of the art knowledge and experience on the learning potentials of virtual narrative, serious gaming and gamification of learning processes
→ Specific knowledge and experience on bringing science learning closer to humanities and narrative as forms of science learning
→ Specific knowledge and experience on the eco-systems of virtual narratives for immersive science learning
→ High-level examples of science learning in virtual narrative spaces
→ Design models for 21st century science learning, based on virtual narrative methodologies
→ Development and production of the project's innovative virtual science learning demonstration models
This competence and capacity role is excellently covered by:
The Serious Games Institute Coventry University (Key top driver)
Cookie Box Barcelona (Co- driver)

21st century youth and learning culture research expertise

The involved partners will provide:
→ State of the art research and knowledge on changing youth cultures in European, including changing learning strategies and preferences
→ Specific knowledge on the role of media, social networks and virtual gaming in changing youth cultures and learning patters
→ Forecast analysis of 21st century learning strategies for young people in Europe
→ Specific knowledge and insight on resistance towards science and science learning among young people and the future perspectives of this resistance
→ Co-design of attractive science learning and career promoting narrative virtual models for 21st century youth
This competence and capacity role is excellently covered by:
Department of Learning and Creativity, Aalborg University, Copenhagen - Research Centre for Creative and Immersive Learning Environments (Key top driver)
University of East London - CIME (Co- driver)

Co-drivers of key support fields of expertise in the field of science learning and attractiveness ["co-drivers"] include:

Science youth careering expertise

The involved partner will provide:
→ Knowledge and experience on young people's science career choices and their backgrounds
→ Knowledge and experience from extensive community based experimentative practice with alternative science careering among young people
→ Knowledge and experience from experimentation with digital narrative and gaming as science interest and career promotion
→ Co-design of innovative virtual narrative science learning spaces and analysis of their impact on young people's science careering
This competence and capacity role is excellently covered by:
University of East London - CIME (Co- driver)

User-driven innovation and co-creation expertise

The involved partner will provide:
→ State of the art research and knowledge on user-driven innovation and co-creation with a special view to young people
→ Efficient strategies for the involvement of young people and their teachers in the various project phases, including the evaluation of this involvement
→ Expert contributions to the user-driven and co-creative dimensions in the development of the virtual narrative science learning spaces
This competence and capacity role is excellently covered by:
Centre for User Experience Research (CUO) – iMinds, KU Leuven (Co- driver)

European innovation and impact quality expertise

The involved partner will provide:
→ Expert strategies for the quality assurance of the innovation generated by the project
→ Expert strategies for the evaluation of the project's user-driven and co-creative methodologies
→ Expert assessment of the relevance, usability and potential impact of the project's key outcomes
→ Expert assessment of the quality and value of the project's contributions to European research and innovation in the fields of science learning and

careering innovation, and with a special view to the exploitation potentials of virtual narrative attractiveness strategies

→ Expertise in the epistemological field of critically re-thinking and deconstructing the traditional discourse of science learning as a pre-condition for developing attractive science learning in schools and elsewhere

This competence and capacity role is excellently covered by:
Working with Europe (Co- driver)

Co-creators of science learning and attractiveness innovation impact and usability ["co-creators"] include:

Secondary schools - formal science education

The involved partners will provide:

→ Practical experience from science learning in formal education (secondary school)
→ Dialogue forums for assessing the quality and relevance of the project's processes and products
→ Co-creation of the project's progressive didactic and virtual narrative design
→ Test spaces for direct testing of the project's virtual narrative concepts and demonstration models
→ Ongoing feedback from real-life science learning practice

This co-creation role is covered by:
Platon Schools, Greece
Istituto Comprensivo Cittadella Centro, Italy
Banyoles Secondary School, Spain
Christela School, Portugal

Science centres -non-formal science education

The involved partners will provide:

→ Practical experience from science learning in non-formal education (open science centers)
→ Dialogue forums for assessing the quality and relevance of the project's processes and products
→ Co-creation of the project's progressive didactic and virtual narrative design
→ Test spaces for direct testing of the project's virtual narrative concepts and demonstration models
→ Ongoing feedback from real-life science learning practice

This co-creation role is covered by:
Kaunas Science and Technology Park, Lithuania
Laboratory of Experimental Sciences in Foligno, Italy

Partners

UNIVERSITY STEFAN CEL MARE
Romania
Including science learning expert Professor Jonathan Osborne, UK/US

UNIVERSITY OF HELSINKI
Finland

AALBORG UNIVERSITY – RECREATE
Denmark

SERIOUS GAMES INSTITUTE COVENTRY UNIVERSITY
UK

COOKIE BOX S.L. BARCELONA
Catalonia Spain
Including virtual story-telling expert Christian Fonnesbech, DK

UNIVERSITY OF EAST LONDON – CIME
UK

KU LEUVEN
Belgium

WORKING WITH EUROPE ASS.
Catalonia Spain

KAUNAS SCIENCE AND TECHNOLOGY PARK
Lithuania

LABORATORY OF EXPERIMENTAL SCIENCES
Italy

PLATON SCHOOLS – PLT
Greece

ISTITUTO COMPRENSIVO CITTADELLA CENTRO
Italy

INS PERE ALSIUS I TORRENT
Catalonia Spain

CRISTELO SCHOOL - AGRUPAMENTO ESCOLAS DE CRISTELO
Portugal

SCI*gamer* work package progression