SCI*gamer*

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 development of the SCI*gamer* project concept.
For interest in the presentation of the project in the Horizon application, please see
SCIgamer presentation.
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
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OPENINGS

> Given the wealth of research studies conducted to date, it could be argued that we already know all we need to know about how young people make educational choices. From this perspective, the main challenge now is to develop research informed educational interventions and associated practices that impact on how young people see STEM in relation to their educational and career aspirations…
> Our perspective is that research activity is still needed, but that more effort needs to be placed on the design and long-term evaluation of educational interventions aiming to impact on subject choice.
> *Understanding Student Participation and Choice in Science and Technology Education,* 2015

> Co-creation and user involvement increasingly drive innovation today.
> To understand how new generations think and act may require a whole new set of skills or even a new company culture.
> Users are being involved in earlier phases of the innovation process - the innovation process is becoming user-driven.
> OECD 2009, *New Nature of Innovation*

After 400 pages the excellent book *Understanding Student Participation and Choice in Science and Technology Education* from 2015 (based on the European Commission supported IRIS research project) – to be considered state of the art of what we know about student's attitudes towards science learning and resulting career choices – boldly concludes that what we need now is *science learning research linked directly to innovation and practical experimentation*.

This direct invitation and recommended 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 *Science Learning and Careering 3.0* 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 mindsets.

In simply words: it seems as we know what is happening, even what might be the reasons, *but we do not know what to do about it*…
This is the challenge the project will address.

The *Science Learning and Careering 3.0* 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.

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A DRAMATIC, DRAMA-BASED AND FUNDAMENTAL CHANGE

> One danger with trying to make science interesting to children of whatever age is that it merely becomes entertaining, and that at best they remember an amusing trick, but forgets, or never learns, the science it was supposed to illustrate. This may be the case with one-off visits to science museums or exhibitions, where the novelty and excitement of the day out are what make the biggest impression. The most successful efforts therefore will seek to integrate the fun into an overall strategy based on generating and sustaining interest in the scientific process and practices. This can take place inside and outside the classroom.

> OECD 2008, *Increasing students' interest*
>
> We believe that in any academic discipline, there are elements that are fundamentally game-like
> Klopfer, Osterweil and Salen, *Moving learning games forward*, 2009

One of the most promising recent research results is pointing to bringing science and science education out of its closed and esoteric discourse and linking science understanding to the privileged discourse of humanities: *narrative*.
The sterile and potentially alienating science discourse is not digestible for 21st century children and youth. Perhaps it never was…

Thus well-established and un-contradicted research recommends a dramatic and fundamental change in the discourse of science learning and science careering.
And precisely a *drama*-tic change, introducing narrative as a communication form of science engagement – the narratives of science itself, brought to the forth and serving as generic organizer of science interest.

The narratives of science readily offer a long line of dramas and stories, in which we find scientists in such classic narrative roles as detectives, researchers, journalists, explorers, reporteurs, story-tellers, etc., etc. Furthermore science in its broadest meaning is producing overwhelming amounts of new and diverse explorative narratives every day.
Combining such real-real and real-time narratives of science with plot and mission based work forms and offering explorative 21st century virtual platforms is expected to be a powerful way to innovative traditional or "modernized" science learning and create renewed interest in science and science careering.

> While it is by no means unlikely that many students eventually entering a STEM higher education programme have acquired an interest and inclination towards STEM subjects in the early years of schooling, the point that choices are made over time and involve construction of narratives draws attention to the need for students to be able to continue to construct a viable, recognizable, and convincing narrative through upper-secondary school and beyond.
> *Understanding Student Participation and Choice in Science and Technology Education,* 2015

This is precisely what *Science Learning and Careering 3.0* will research and offer.
The project will explore an integrated model, at the same time facilitating science learning interest and interest in sustaining this through pursuing science education and science career choices, thus *allowing young learners to construct and sustain a science engagement narrative across secondary school and beyond*.
As we know, narratives take time, and this is why 3.0 science learning innovation will need to create science engagement narratives across years, not across weeks or months.
This is the only realistic way out of resistance to science education and careering, and this is how the Call's "forward-looking" should be interpreted.

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

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BRINGING THE BEST TOGETHER

> There are shortcomings in curriculum, pedagogy and assessment, but the deeper problem is one of fundamental purpose. School science education, the authors argue, has never provided a satisfactory education for the majority. Now the evidence is that it is failing in its original purpose, to

> provide a route into science for future scientists. The challenge therefore, is to *re-imagine science education*.
> Osborne and Dillon, *Science education in Europe – Critical reflections* (2008)

Following the Commission' and the OECD's invitations to bring research closer to society and to real change, *Science Learning and Careering 3.0* 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.

To make possible its missions, *Science Learning and Careering 3.0* 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 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 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.

SCIENCE LEARNING AND SCIENCE CAREERING 3.0

> …narrative strategies of fiction may be more appropriate for representing science than the expository textual practices that have dominated science and environmental education to date. It is through literary fiction, he states, that the problems of human interrelationships with environments become intelligible.

> Osborne, *The Role of Narrative in Communicating Science* (2008)
>
> An educational game should put players in touch with what is fundamentally engaging about the subject, should help them build a scaffolding of core concepts, and should motivate them to go deeper
> Klopfer, Osterweil and Salen, *Moving learning games forward*, 2009

The project identifies itself as a necessary historic change in the discourse of science education, and position itself at a crucial point of hard-to-reach but still within-reach innovation:

1.0

Traditional science education and careering 1.0 is failing, as evidenced by an entire research community and confirmed by key leading policy institutions such as the OECD and the European Commission.

2.0

Recent innovative science learning and careering initiatives are offering positive new science experience opportunities for secondary students, including outdoor eventing, stand-alone gaming and more media based science learning activities
Albeit positive, these punctual and very limited science learning interest attempts are not basically changing science learning, science careering or the image of science – they are not offering forward-looking 21st century science attractiveness.
Science learning in schools needs systematic and pervasive forward-looking solutions, beyond punctual improvements of outdated science teaching.
Such attempts merely offer "modernization" of existing science learning didactics, not likely to basically impact resistance to science.
Future science learning engagement cannot be brought about through an *addition* of modernized science learning events, only through a *fundamental shift* in the discourse and didactics of science learning.

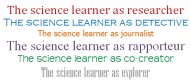
3.0

Forward-looking and future-oriented science learning must innovate the very discourse of science and the way science is experienced by school children and young students.
Guided by leading researchers the project will base science learning innovation – not on the intervention of external discourses – but on the *dramatic structures and narratives of science itself*, offering an *immanent* approach to a new systematic science learning didactics from the inner life of science.
Whereas virtual technology might be the facilitator of science engagement, narrative is the driver.
Such narratives from the science itself connect seamlessly and readily to 21st century virtual dramatization such as simulation, serious gaming, gamification and open mission-based and explorative collaborative platforms.
Science learning and science careering 3.0 will therefore offer a full-blooded virtual science learning and careering experience following the young students all along secondary school and easily integratable in any formal or non-formal science learning setting, precisely allowing young students to build up long-term creation of *positive science narratives* with which they can identify.

4.0

As predicted by game learning pioneer Marc Prensky, 3.0 science learning and careering is likely to be followed by science learning 4.0, in which the students will produce their own science learning didactics, material and stories, based on open virtual collaborative networks.
Science learning and science careering 3.0 will carefully anticipate such futuring through researching and building those future perspectives into its concept and virtual platform through students' co-feed and co-creation of real-life and real-time science narratives. This dimension in the project represents an open-ended exploration.

However, one cannot short-cut history and experience: therefore substantial knowledge creating and practical experimentation in 3.0 is needed to create readiness to engage in the future perspectives described by Prensky.



WHAT WILL RESULT?

> Current science curricula, also in the early ages, are to a large extent based on the assumption that school science is the first step in the process to educate the future scientist. Curricula follow the logic and the structure of well-established academic science. Although "logical" from a scientific point of view, this is not likely to be engaging for the great majority of children.
> Sjöberg and Schreiner, *ROSE project Key findings* (2010)

> Instead of continuing to think of future schooling in terms of allocating time to subjects, right now we should make a bold move and rethink the way time is organized in schools.
> Sahlberg, *Finnish lessons* 2.0, 2015

The project will, based on its 3-strands research and direct linking to innovation and change, produce the following outcomes:


Create a demonstration model of the dramatized virtual platform in collaboration with the involved students

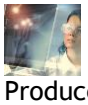

Test the demonstration model among participating secondary students + social networks


Produce a full or limited version of the dramatized science virtual platform

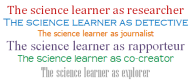

Produce and publish a didactic virtual platform guide for schools and teachers in formal and non-formal youth education


Produce a technical guide for co-feed and co-creation for students and teachers, integrated in the platform itself


Develop a sustainable research, business and management plan for the continued full operational capacity of the virtual platform, including plans for possible language versioning


Produce and public a research and policy paper: *Science learning and science careering 3.0*

Produce 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



RESEARCH, INNOVATION – AND IMPACT!

> But young people do not choose their studies or careers because it is good for the domestic economy. Instead, they base their choices (when they have such choices) on their own interests, values and priorities.
> Sjöberg and Schreiner, *How do students perceive science and technology?* (2006)

> The irony of the current situation is that somehow we have managed to transform a school subject which engages nearly all young people in primary schools, and which many would argue is the crowning intellectual achievement of European society, into one which the majority find alienating by the time they leave school. In such a context, to do nothing is not an option.
> Osborne and Dillon, *Science education in Europe – Critical reflections* (2008)

European Commission and the OECD jointly recommend bringing research closer to reality, closer to society and creating real impact and change.
The state of the art book from 2015 - *Understanding Student Participation and Choice in Science and Technology Education* – concludes that research now should move forward into innovation, experimentation and generate real impact.
This is also the key message in the SEAC 1 Call.

Science Learning and Careering 3.0 is responding to this challenge.

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.

Therefore the project 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 and community based 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?

The project research packages will allow the development of innovative solutions, in close interaction with young learners and their teachers.

The project's outcomes will therefore consist in the demonstration and implementation of practical innovation and therefore directly impact the critical situation addressed.

Science Learning and Careering 3.0 will work its way from mobilizing established knowledge to researching conditions and premises for change to demonstrating innovative solutions and to directly impact the problem addressed.

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RESEARCH APPROACH – CO-CREATION AND CO- KNOWLEDGING

> According to Seymour, students imagined that, in order to pursue SME careers, they would have to embrace a persona which was alien to their own personality. They portrayed engineers, especially, as dull, unsociable (often materialistic) people who lacked a personal or social life and were unable to relate comfortably to non-engineers. They were also portrayed as uncreative people, who avoided or decried the idea of a broader education. Some thought that science tended to attract people who already had these personality traits.
> OECD 2008, *Increasing students' interest*
>
> One place to start is by asking students…
> OECD 2008, *Increasing students' interest*

Science learning must change, and therefore also research in science learning must 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 ongoing deconstruction of what science and research means.
We are witnessing the secularization of research, and this will strongly impact the *Science Learning and Careering 3.0* 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.

Science Learning and Careering 3.0 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 ongoing 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.

Resistance to science education and careering is a multidisciplinary challenge, as the narratives (positive or negative) that the young learners are building up about science are deeply integrated with the emerging personal narratives, on which the young people will build their personalities - and such challenges can only be addressed through multi-disciplinary approaches.
This is why all science education research partners in the project will form multidisciplinary teams.
To this end, it is of extreme importance to the project's research approaches to understand the <u>double impact</u> <u>and benefit</u> of bringing narrative to the forth in science learning and careering:

Narrative as a communication form and new discourse of science learning
(The creation of scientific meaning)
⇔
Narrative as the language in which one builds up identify and personality
(The creation of individual meaning of life)

Bringing narrative to the forth therefore makes possible the paramount **CONNECTION between what you learn and who you are**, thereby allowing the different and personalized contact to science learning and careering demanded by 21st century youth and young people's present and future life styles.
Narrative is the bridge and mediator, and virtual exploration makes science narrative exciting.

It can be illustrated like this:

Traditional science learning discourse // 21st century youth

⇐ NARRATIVE ⇒

Innovative science learning discourse ↔ 21st century youth

This has deep bearings on the project's research approaches, as narrative didactics and virtual narrative didactics can only be researched through qualitative approaches, precisely because they link to the creation of personal narratives and identity that cannot by definition be quantified.

What can be validly quantitatively researched is the possible systematic career IMPACT of those processes, and this can and will happen in the follow-up project 2019-22, researching qualitatively as well as quantitavely the impact on career choices and attitudes towards science of the *Science Learning and Careering 3.0* innovation.

The project will therefore along its research and design phases not engage in traditional quantitative research methods, but work closely and interact with a limited number of the young learners in the secondary schools involved in the project, including their social networking.
The schools are very different, from different countries and cultures, and so are the young people.
The group of young people (around 100 expected) in secondary school (from 11 to 14 of age) will constitute a most dynamic partner in the project and be fully involved in the research, design and development phases and will evidently be the key players in the testing.
The involvement of the young people, and to some extent their teachers and parents, will happen through a variety of qualitative approaches.

The project will, however, engage with a larger number of science learning students in the testing of the full demonstration production in the middle of the third year.
A number of secondary schools from different countries, identified through the key partners' European networks, will be invited to take part in an evaluation of the narrative virtual science learning space and deliver structured teacher-led feedback through online questionnaires.
This focused wider and quantitative evaluation will produce useful first knowledge in combination with the in-project science learners' reactions and testing.
This first large-scale evaluation will be followed by the planned 2019-22 research project, taking the usability testing to a systematic research level.

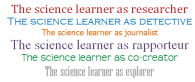
In parallel to the need for studies across longer time spans, the project will rely on perhaps the most important research result as to resistance towards science education and careering: the fact that this resistance seems to be built up along the 2-3 first years of secondary school, precisely when science education is split into subjects and when the children start to create their own personality and narrative.
Much evidence confirms that the age from 12 to 14 is the most important years as to developing long-lasting feelings, attitudes and relations to the world of science learning, resulting in little interest in science education choices at the age of 15.

The negative science choice at 15 is a simple consequence of the early secondary school experience. Therefore science careering cannot be changed, unless science experience in secondary school is changed.
Initiatives addressing science careering directly and unmediated will therefore most likely fail.

The project responds to this important knowledge through creating narrative based virtual science learning for continuous engagement along this important time period.
This leads to a very important criteria for developing innovate and attractive science learning:

In the same way as resistance or disengagement in science education in secondary is systematically built up over a period of 2-3 years, engagement and interest in science learning need to be built up along similar time spans.
Stand-alone and punctual science events, how interesting they might be, are deemed to fail.

The project's research and innovation methods are designed to be in accordance with this precious knowledge.



ANTICIPATING THE NEW FORMS OF SCIENCE LEARNER ENGAGEMENT: ATTRACTIVE STUDENT ENGAGEMENT IN THE PROJECT RESEARCH

> One of the key messages is that the relevance of S&T to students' concerns should be a central part of how science is taught and represented, not an optional extra brought in occasionally to try to boost flagging interest.
> OECD 2008, *Increasing students' interest*

Form and content is interacting. Subject and object is 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.

Science Learning and Careering 3.0 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.

Science Learning and Careering 3.0 is considered mission impossible unless its approach to the challenge and to the young people addressed includes such serious epistemological self-reflections:

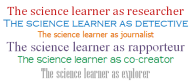
NO INNOVATION IN SCIENCE LEARNING AND CAREERING WITHOUT INNOVATION IN THE RESEARCH APPROACHES BOUND TO BRING ABOUT SUCH INNOVATION

In the project and embedded in the research mission is the interaction between narrative and community interaction, forming a powerful mixed reality experience.

Adding both narratives and game mechanics to digital learning content has been somewhat explored in recent years; however, it was not until “community” was added to the mix that a real jump in learning benefits could be observed.

By "community", we mean two things: at the micro level, community is about the kind of focused student-to-student discussion (and the ability to rate other people's discussion posts) that the Internet and it's social networking interfaces enables so well - and which allow real and active problem solving to take place, and also allow students to experience the satisfaction of helping/teaching each other.

At the macro level, it is about long term relationship building among participants and engendering a real feeling of validation through shared interests ... and ultimately a shared sense of identity around science.



CRITERIA FOR A NARRATIVE BASED VIRTUAL SCIENCE LEARNING AND CAREERING PLATFORM

> Many of those who had made a decision in favour of or against a career in science and engineering had done so before age 14…
> OECD 2008, *Increasing students’ interest*

> Because the next generation of educational games – the games that will truly engage and teach students – is likely to come from the minds of other students, rather than from their teachers. And it is likely that learners will relate to these games, and learn from them, in a way that is not happening today.
> Prensky, *Students as game designers*, 2007

First, what should the project not develop; then, what should the project develop?

1
The project should not produce a commercial digital game, for obvious reasons

2
The project should not produce a closed and stand-alone serious digital game. The use of such a game would be limited in time and scope.
The game would be extremely expensive to produce, as a digital serious game would need to compete on quality and gameplay with the famous commercial games – the costs would far exceed a Horizon budget!
The game would be very complicated and costly to update.
It would be complicated for users to contribute to the game.

3
The project should not primarily engage in producing a number of small and subject-related games, as such subject-related games are already widely

available and do not link well to the general innovation in science learning the project will undertake.
However, such stand-alone games are likely to be mobilized, alongside other online resources, as possible resources in the science quests in the virtual narratives.

 4
The project should not engage in what could be called gamification of already existing science education, as the impact of this would be quite limited, punctual and not able to generate the needed in-depth and systematic innovation.
However, gamification principles are already by definition built into *The story is the game* approach.

It is important to note that the virtual space must be able to allow the young science learners to engage across a time period of 2-3 years, as this is the very innovation of the project: *combining exciting science learning in secondary with science careering preferences into one unique concept*.

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.

Once again, creating competitive serious games – with avatars, HQ graphics, intelligent gameplay, etc. – is a very costly affair, and can only be undertaken on solid commercial terms and conditions. That's, by the way, why such games are not being produced!
The development and production costs would most likely be at the level of several times the total expected SEAC grant.

And: producing a low quality science game would not in any way have an impact on the young people, on the contrary. It would look like: "the educational world is trying to do what real games have been doing for a long… forget it!"
This would most likely create more resistance…

Luckily we don't have to do that.
There are better options – the 3.0 options.

What should the virtual science space be like and able to do?


Twenty possible criteria and principles, representing the "juice" of the project innovation

 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

The virtual space combines narration and community interaction into a powerful cocktail, allowing a dynamic mixed reality experience in which student's collaborate with students and in local and virtual communities

 3
The virtual science space should not try to replace science learning in secondary school, but should offer a parallel and independent space readily integratable 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 immanent 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 intrinsic 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 "time to build up narratives principle"): 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: how to feed, who will feed, when to feed and what to feed?
Research should also include: to what extent and in what ways can teachers and learners co-create and feed the platform with real-life science narratives – and to what extent can this 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
NB! The use of advanced material, for example 3-D, does not in itself provide exciting and challenging exploration; often the contrary is the case

 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, when possible

 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, provided through media news
- Researching the drama
- Identifying the problem or the conflict and its elements
- Detecting the background to the drama
- Creating and finding the needed resources to work through the problem including the needed science knowledge; the science "learning" when needed approach
- 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

As can be seen there is no real "game" here, but a lot of game-like drama and exploration: Fonnesbech: *The story is the game!*

 15

A special and extremely innovative grip to be researched and tested in the project is the virtual narrative's "own time" – no matter if the narrative is generated by real events or constructed as a fiction (both directions are possible).

The narrative course of events will be experienced as "real" by the young science learners, as the events will take place no matter the possible reaction from or intervention of the learners.
The science events "happen" without being triggered by the learners' actions.
The science learners might for example experience an invitation to help from one of the narrative characters, but also that the "lives" and "challenges" of the narrative characters continue independent of the users' intervention.
This cross-over approach between real-time and narrative time is extremely promising, but needs considerable research and practical testing to be optimized and to be deliver the special immersive dynamics that makes the learning not only attractive but *urgent*.
Along the project's research missions we will call this special grip *time cross-over*.

 16
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 2-3 year period

 17
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
NB! The project is a research and innovation project, not primarily a production project

 18
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 learners' content co-creation and knowledge brokering

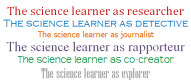
 19
The science drama challenges might be constructed as missions and levels (sub-missions), and this will bring the exploration and detecting closer to the concept of a serious game; however, and if so, this should be built into the basic design of the virtual platform and its structures

 20
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

 21
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

[To be systemized in the application]



THE LOGICAL PROGRESSION OF THE PROJECT

> One danger with trying to make science interesting to children of whatever age is that it merely becomes entertaining, and that at best they remember an amusing trick, but forgets, or never learns, the science it was supposed to illustrate. This may be the case with one-off visits to science museums or exhibitions, where the novelty and excitement of the day out are what make the biggest impression. The most successful efforts therefore will seek to integrate the fun into an overall strategy based on generating and sustaining interest in the scientific process and practices. This can take place inside and outside the classroom.
> OECD 2008, *Increasing students' interest*

EVIDENCE

Basing the project research mission on the following evidence, not in need of research in the project:

- Considerable science resistance is built up along secondary school, resulting in a lack of science careering interest
- Serious gaming, gamification and narrative virtual spaces are recognized as possible motivators of renewed science interest among students at all ages
- Any innovation in science learning in schools must link strongly to 21st century youth and to 21st century learning

⇓

RESEARCH

The project's research missions could be organized in 3 big research packages

1
Researching secondary school students' expectations towards innovative and dramatically different science learning and their expectations towards new virtual science learning and careering didactics (perspective: present)
[Detailed into 3 or 4 research topics]

2
Researching the design and development of the eco-systems of immersive narrative virtual science spaces (perspective: present)

3
Researching how young science learners and their teachers can co-create narrative science missions and continuously feed the virtual eco-system (perspective: near future / future)

⇓

INNOVATION

Delivered through the production and testing of various versions of the immersive narrative virtual science spaces

⇓

IMPLEMENTATION

Post-project implementation + new research project 2019-22
[This might include the following work packages:]

This progression logic can be unfolding in a parallel optic, seen from the point of view of the young science learner:

"IF I can build attractive and exciting narratives of what science is and can be along my first years in secondary"

⇓

"AND IF I can integrate those science narratives in the development of my own personal style narratives"

⇓

"AND IF I am allowed to hold on to, sustain and further develop such integrated narratives along my first years in secondary"

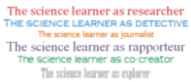
⇓

"THEN I might be interested in pursuing science quests and careers after secondary"

⇓

"OR at least I will grow up with a very different attitude towards science and science challenges, and I might use this attitude to engage in exciting science activities in parallel to my work"

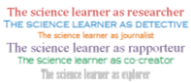
This is what the Commission asks for, and this is what we will try to demonstrate.



THE RESEARCH AND INNOVATION CONSORTIUM CONSTRUCTION

> …Five technology-supported pedagogic models emerging from the Initiative are highlighted: gaming, virtual laboratories, international collaborative projects, real-time formative assessment and skills-based assessment. These models have the potential to improve students' learning outcomes, including development of higher-order thinking skills, and to expand the range of learning opportunities made available to students.
> OECD 2013, *Sparking Innovation in STEM education*

[Please refer to the documents *SEAC Final Consortium* and *SEAC Consortium as a whole - draft*]



KEY REFERENCES

> A game is able to provide that opportunity for appropriate guidance or collaboration in order to help players meet the next challenge. The stepwise increase in difficulty reduces frustration and allows players to form knowledge and strategies that will be useful later (Gee, 2003). A state of pleasant frustration—challenging but doable—is an ideal state for learning several content areas such as science (diSessa, 2000).
> *Gaming in education*, Pearson Report, 2012

> Educational gaming offers a promising model to enhance student learning in STEM education, not just improving content knowledge, but also motivation and thinking and creativity skills. Educators and policy makers should

> consider using it to enhance STEM learning outcomes and problem-solving skills and motivation. Designing games appears to lead to even deeper learning than just using them for educational purposes.
> OECD 2013, *Sparking Innovation in STEM education*

The preparation of the *Science Learning and Careering 3.0* application included reviewing and studying a long line of publications and papers, of which the most significant are:

Policy

EU Commission 2007 - Science education NOW
Europe needs more scientists – 2004
OECD 2008 Increasing students' interest
OECD 2013 Sparking Innovation in STEM education
Science education for the 21 century – 2007
Science Education in Europe - Commission 2011
Science with and for society – Commission
Scientix - the European Science Education community
Students interest in science OECD

Science education research

EU science interest barometer 2005
EU science interest barometer 2011
EU science interest barometer 2014
How students see science and technology
Narrative in communication science 2008
Osborne - Attitudes towards science – 2004
PISA and real life challenges
Research on young people's perception
ROSE project Key findings
ROSE project Questionnaire
Science education and Identity
Science interest in different cultures
Sjöberg PISA critique
Understanding Student Participation in Science and Technology - 2015
Young people, science and technology

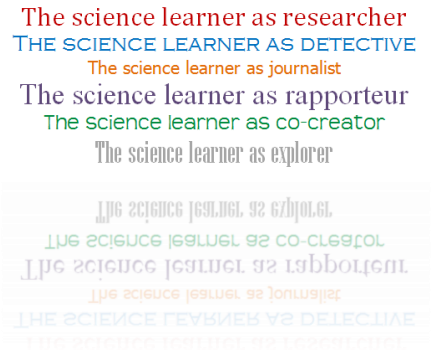
Narratives, serious gaming and gamification

The Gamification of learning and instruction
Kapp, 2012
The ecology of games
Salen, 2008
What video games have to teach us about learning and literacy
Gee, 2007
Digital game-based learning
Prensky, 2001
Teaching digital natives
Prensky, 2010
Reality is broken
McGonigal, 2011
21st century skills and games – 2008
Literature list games in education
Moving learning games forward – 2009
Review of gaming in education 2012
Scientific minds in virtual worlds – 2008
Students as game designers
Virtual worlds

Narration and plot

Peter Brooks, Reading for the Plot

[Reference details to be provided in the application]



Why are students building these games, to be used by their contemporaries or by other students further down the grades? Why are they not being built rather by teachers, or other adult professionals? Because, try as they might, the grownups don't fully understand the minds of today's students, and the games they produce reflect this. "Quite often, educational games or games for education created by educators or textbook publishing houses smell too much like school," says Professor Cher Ping Lim. "Although various gaming elements such as narratives, point system, and challenges and levels are integrated into the virtual environment, the environment is often a replication of the existing power relations in the school where teachers and textbooks are the fountain of knowledge and students are empty vessels to be filled with knowledge. Students are not empowered to make decisions and take actions in these games about the political, cultural and social fabric in such environment."
A student puts it much more simply: "Don't try to use our technology," she says, "you'll only look stupid."
An entire generation of educational software – the stuff known as "edutainment" – was either (literally) dumped into holes in the ground, or sold off at a tiny fraction of its original cost. Why? Because the students had no input into its creation, and the stuff came out cute to the adults, but boring to the kids.

Prensky, *Students as game designers*, 2007