



## **Deliverable 6.1**

# **OSOS Assessment Methodology**



Funded by the Horizon 2020  
Framework Programme of the  
European Union

This project has received funding from the European Union's Horizon 2020 Framework Programme under grant agreement No. 741572

### Document Control Page

<b>WP/Task</b>	WP6 / T6.1
<b>Title</b>	D6.1 OSOS Assessment Methodology
<b>Due date</b>	31/10/2017 (According to the DoA)
<b>Submission date</b>	
<b>Abstract</b>	This document outlines the impact assessment framework for the OSOS project. The methodology described is drawn from the current interlinking evaluation methodologies on organisational change, RRI and educational practices in science education. The proposed methodology aims provide the information on how to assess the impact of OSOS project at two levels: at the school (organisational change, RRI integration) and at the student level (interest and motivation in science, problem solving). It also aims to ensure the uptake of relevant stakeholders through the systematic monitoring of OSOS Open Schooling Model, the OSOS Strategies and implementation activities. The proposed assessment methodology offers the main framework for validating the pilot phase of the OSOS project.
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<b>Dissemination level</b>	<input type="checkbox"/> internal <input type="checkbox"/> public <input checked="" type="checkbox"/> confidential

### Document Control Page

Version	Date	Modified by	Comments
01	19/9/2017	DCU	1 <sup>st</sup> draft delivered by DCU
02	20/9/2017	DCU/EA/SV	D6.1 Meeting at DCU and detailed discussion on the draft version – Comments and additions – Harmonization with WP2 deliverables
03	9/10/2017	SV/DCU/EA/UBT	Integration of the comments/input from EA, SV and UBT SV: Organisational Change UBT: Interest and Motivation EA: Problem Solving
04	23/10/2017	SV	Integration of the comments for changes in the structure of the document and more detailed description of the organisational change assessment.
05	26/10/2017	DCU/SV/EA	Final Version



## Executive Summary

This document describes the OSOS Impact Assessment methodology. It includes a review of relevant theoretical and practical approaches (including an extended review of relevant initiatives in the field presented in APENDIX) in evaluation of school innovation, science education approaches on evaluating students' problem-solving competence, interest and motivation in science which align with Responsible Research and Innovation (RRI) principles. According to the OSOS approach these areas of interest (school organisational change and students' attitudes towards science) could provide evidence and the basis for demonstrating the foreseen project impacts. The main aim of the document is to describe how to assess the school's openness according the proposed Open Schooling Model (D2.1) as well as the strategies for its implementation (D2.2). The project team has designed a hybrid evaluation approach that builds on the existing frameworks and metrics but also to innovative methods for monitoring the schools' development through the implementation of the OSOS Model. This document will describe assessment procedure and criteria that will be implemented and measured during the three phases of the OSOS project pilot phases, initially with 100, and then with 1000 schools in different European countries

In Chapter 1 the main axes of the OSOS evaluation framework are presented. The Impact Assessment Methodology will be based on the two driving forces of the Open Schooling Model (see D2.1): a) Rethinking How Schools Work and b) Shift from Students as Consumers to Creators. To monitor these crucial characteristics of the Open Schooling Environment the OSOS evaluation team will focus on the assessment of the Organisational Change and at the same time the evaluation of the Pedagogical Impact (as far as students' attitudes and skills are concerned) of the proposed activities in the school settings.

Chapter 2 presents the description of the framework and how the assessment approach is going to take place. The scope of the OSOS Assessment Framework is to achieve to measure the Schools' Openness according to the Open Schooling Model (D2.1) and the strategies that were identified in D2.2. Through the three identified phases of "openness" and "growth" – stimulation, incubation and acceleration phases –, the OSOS Impact Assessment team will be looking for clear evidence of significant increase of 1) mass, 2) density, 3) temperature, and 4) reflectivity that are expected to catalyse the innovation process, while placed, purposeful, passion-led and pervasive projects and activities are introduced in the school settings.

In Chapter 3 the main aspects and objects that will be assessed during the project's lifetime, are described. The project team has come up with 40 indicators that will be monitored during the process through different instruments and techniques. Figure 3.3 on page 29 represents the overall assessment framework for the project.

Chapter 4 describes a series of instruments that the project team will adopt and develop along with the necessary infrastructure (to be presented in detail in D6.2) for measuring the progression along the development of the OSOS pilot schools and the realization of the students' projects. Numerous examples from previous projects are presented to offer an overview of the expected evaluation results of OSOS.

Chapter 5 includes a short description of the stakeholders who will be involved in the evaluation process. It describes how the National Coordinators (acting at the intermediate level) are going to support the assessment procedures in the local settings in the framework of the project's large scale implementation. The target communities will provide feedback from the OSOS activities within the schools in this user-centred approach.

Chapter 6 presents the timeframe of the OSOS Assessment Framework. The project team is presenting the initial plan for data collection. It has to be noted that this overall time frame will be adopted and localised by the National Coordinators to the different pilot sites.



Chapter 7 presents conclusions of the current work and describes the future action in the framework of WP6 during the whole project cycle.



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# 1 Introduction

## 1.1 Purpose of the document

To maximise the impact of OSOS project and to ensure the uptake of its results by education practitioners in schools and policy makers, the project will systematically monitor and evaluate OSOS methodology and activities. This deliverable describes the OSOS Impact Assessment Framework consisting of an integrated evaluation methodology that builds on two main axes and a set of measurable quantitative and qualitative indicators to gauge the effectiveness and impact of the OSOS approach. Additionally, the team aims to examine economies of scale to increase impact into the future, by intensive examination of OSOS Open Schooling pilot hubs and their interactions with their local communities. This will take a holistic trans-disciplinary and trans-national approach to evaluation.

Through the three identified phases of “openness” and “growth” – stimulation, incubation and acceleration phases –, the OSOS Impact Assessment team will be looking for clear evidence of significant increase of 1) **mass**, 2) **density**, 3) **temperature**, and 4) **reflectivity** that are expected to catalyse the innovation process, while **placed**, **purposeful**, **passion-led** and **pervasive** projects and activities are introduced in the school settings.

The Impact Assessment Methodology will be based on the two driving forces of the Open Schooling Model (see D2.1):

- Rethinking How Schools Work
- Shift from Students as Consumers to Creators

The aim of the project team is to map these processes and to add its contribution towards the development of these future trends. More specifically the project team will focus on assessing the organisational and cultural change that is crucial for the implementation of the open schooling approaches. It will explore the sustainability and the cost effectiveness of the proposed approaches. It will explore some key characteristics of the related science pedagogy by focusing on students' motivation and interest. Finally it will explore how existing and emerging technological solutions could help or could create obstacles in the uptake of open schooling approaches in different school communities across Europe. The key areas for monitoring the open schooling process are described in the following:

- **Organisational and Cultural Change:** The Open Schooling Model proposes a change on how the schools should operate. Schools should integrate aspects that up to now in most cases were not included in their plans and strategies. These changes in the school organisational structure as well as the cultural change that is necessary to involve external stakeholders will be measured in order to monitor the impact the project's activities. As the project introducing the RRI aspects to be integrated in the schools' structures, these aspects will be monitored and measured with relevant indicators and tools. A School Development Plan (included in D2.2) along with a self-reflection school instrument will provide direct feedback from school units.
- **Sustainability and Cost Effectiveness:** The model of “Socially-Modified Economic Valuation” - SMEV (Kelly and McNicoll 2011), a Harvard-devised model, which uses a ‘*social weighting*’ measuring the social contribution of collaborative community educational activities, will be used to assess the sustainability and the effectiveness of the opening process. This value accompanies or ‘*shadows*’ the actual economic value. Thus, activities in socially disadvantaged areas would be ‘*worth*’ more in terms of social value generated. Measurements can be done on the basis of, as examples: number of partnerships between schools, local communities and local industry; number of stakeholders involved and interactions; structured or flexible interactions: equity of social capital/ social power of stakeholders in the process; tools and skills acquired by the stakeholders as a result of open schooling activities; tools and skills attachment to pedagogical/ RRI goals?)

- **Science Pedagogy:** The OSOS school based activities are based on the five strand model described in Section 3.4 of D2.1 (Pedagogical Principles in the Design of Open Schooling Activities): Sparking Interest and Excitement; Understanding Scientific Content and Knowledge; Engaging in Scientific Reasoning; Reflecting on Science; Using the Tools and Language of Science; Identifying with the Scientific Enterprise. In this framework the project team will study students' attitudes (interest and motivation) as well as the development of crucial skills (e.g. collaboration and problem solving).
- **Technology – tools, services and infrastructure:** Quantitative and qualitative assessment of the teaching technology pedagogies and infrastructures, while not enforcing “tech-push”, but to utilise Mark Prensky's (2005) cultures of tech innovation, with indicators of 1) Dabbling 2) Old things/old ways 3) Old things/new ways 4) new things and new ways. This is to include direct classroom tools, formal and informal processes, community-building and social media approaches

Different methods and techniques will be employed, including a mix of quantitative and qualitative methods such as document and statistical analysis, interviews, focus groups (during specific events like summers schools and workshops with the national coordinators), tracking of student interest/progression, online survey tools etc. To collect quantitative data an evaluation template with standardized questions and reflection points will be developed. Each OSOS National Coordinator and pilot hub contact point will populate the evaluation template and submit short quarterly reports. Data will be then analysed by the evaluation team capturing specific information such as the number of industry role models engaged, number of students engaged with industry, number of partnerships created. During evaluation, the main issues to consider include:

- The school has a **clear vision and strategy** (an Open School Development Plan) detailing how the school will support students and staff become an Open School
- Strategies to encourage **Problem Solving, Team Work, Active Citizenship, Critical Thinking and Gender Equality** exist
- Strategies/Plans for **professional development of teachers** to foster a change in behaviour, enabling teachers to adapt to a new OSOS open schooling culture and philosophy
- The school supports the **development of an interdisciplinary environment** where students/teachers are encouraged try new ideas and approaches exists
- Students identify and align stakeholder needs with matters of **local social and economic concern**
- School actively promotes the **collaboration with non-formal and informal education providers**, enterprises and civil society organisations
- School engages in a number of projects which demonstrate **external stakeholder involvement**
- There is evidence of **parental engagement** in school projects
- Schools show evidence of engaging in virtual and physical platforms to **develop innovative projects, share ideas, identify and collaborate with other schools** to develop new projects aimed at addressing the **grand societal challenges**
- Teachers/students show evidence of adapting activities and **linking subjects/projects to issues of national or local interest** in connection with the grand challenges
- School has an **ongoing system of teacher and student self-reflection**, discussion and learning set-up
- Schools set up a system to reflect, track and monitor how open school practices have shaped the **school organisational culture**
- Schools encourage and **engage in reflection, discussion and debates** on scientific and societal issues
- There is evidence of an **economic benefit-associated engagement** of all partners
- Schools engage with policy makers to inspire **curriculum change**

Other evaluation techniques and methods will be employed that include tracking the number of institutions that adopted the Open School hub model at staged intervals over the project cycle; getting feedback from the OSOS participating schools as self-assessment reflection questionnaires concerning



their engagement in the OSOS open school hub and comprehensive assessment of potential changes in attitudes, behaviour, knowledge attainment through Problem Solving, Team Work, Active Citizenship, Motivation in RRI and Critical Thinking. The project will also evaluate the potential of OSOS model to integrate more effectively RRI in OSOS pilot schools and more generally in schools across Europe. Specifically, it will assess to what extent teachers, students and other stakeholders engaged through OSOS open schooling approach have a holistic and open view of science, scientific research and major scientific developments. The RRI component of evaluation will include student/teacher engagement reflections; integration of RRI principles into school curricula and teaching practices etc. These reflections and evaluation of curricula and practices will reveal changes in awareness/knowledge aspects/behaviour in relation to the RRI principles - such as gender, ethics, open access, open science, public engagement, governance, socio-economic development and sustainability, social issues related to scientific developments. In addition, impact of the OSOS model on industry partners and non-formal education providers will also be assessed, in particular whether industry partners incorporated any learnings into their business processes, corporate social responsibility (CSR) and public engagement (PE) strategies as a result of the OSOS engagement model.

Apart from the D2.1 and D2.2, the assessment methodology is closely linked with WP8 (Ethics) and T3.2-3.4 Open Schooling Incubators, Networks and Schools Map, T4.1-4.3 Open Schooling Accelerators, Hubs and Development Plan and T5.1-5.3 Large-scale implementation: Localised Open Schooling Plans, Pilot Accelerators, Pilot Events. The OSOS Evaluation Framework is designed on principles of flexibility and modularisation. Adjustments will be made if necessary as the project evolves, in accordance with the evolving requirements.

## **1.2 Scope and audience of the document**

This document aims to present the OSOS Evaluation Framework and to provide the consortium partners with an overview of the Assessment Methodology. The Assessment Methodology is based on the OSOS parameters that contribute to the growth of the school's pathway towards its transformation as an open ecosystem. The OSOS Assessment Methodology and the Impact Tools will be applied and tested during pilot phase of the project with 100 schools. The Assessment Methodology and the Impact Tools (D6.2) will be reviewed and updated (if necessary) after this initial period. Any update will be integrated to the methodology before the starting point of the second pilot phase where 900 additional schools will take part.

## 2 Assessment Framework and Methodology in OSOS

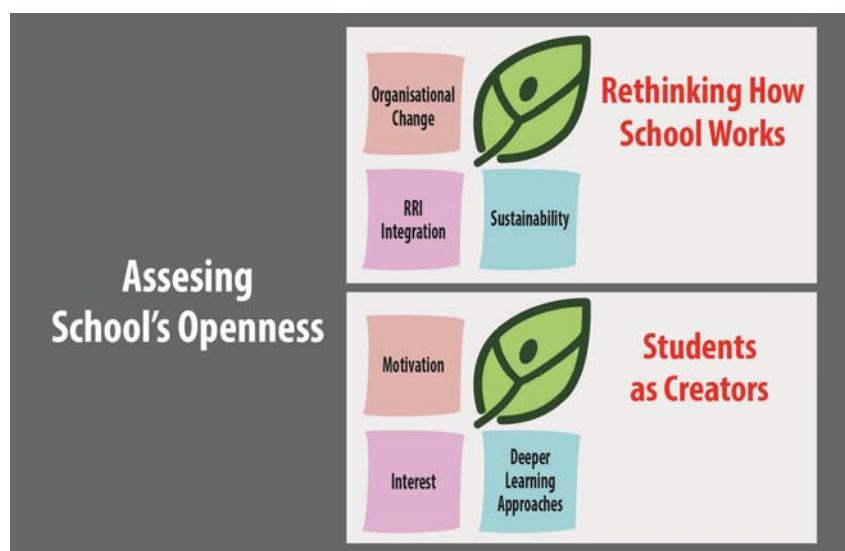
### 2.1 OSOS Assessment Framework

Through the three identified phases of “openness” and “growth” – stimulation, incubation and acceleration phases –, the OSOS Impact Assessment team will be looking for clear evidence of significant increase of 1) **mass**, 2) **density**, 3) **temperature**, and 4) **reflectivity** that are expected to catalyse the innovation process, while **placed**, **purposeful**, **passion-led** and **pervasive** projects and activities are introduced in the school settings<sup>1</sup>. The development of the OSOS Assessment Framework was informed through an extended review of relevant project reports and documents referring to science pedagogy, RRI integration in school settings, organisational change in schools as well as to reflective processes that are based on self-reflection tools. The review includes assessment of evaluation procedures and experiences in previous or on-going science education projects that also integrate RRI principles. The EC Reports and the projects reviewed are presented in detail in Appendix (Chapter 9).

Figure 2.1 describes the overall Assessment Framework that is proposed by the project team. The Impact Assessment Methodology will be based on the two driving forces of the Open Schooling Model (see D2.1):

- Rethinking How Schools Work
- Shift from Students as Consumers to Creators

The project team will focus on assessing the **organisational change** that is crucial for the implementation of the open schooling approaches, which are based on the **RRI principles**. It will explore the **sustainability and the cost effectiveness** of the proposed approaches in order to inform the interested stakeholders at policy levels for the necessary investments. It will explore some key characteristics of the related science pedagogy by focusing on **students’ motivation and interest**. Additionally, it aims to demonstrate that such an educational environment (Open School) promotes **deeper learning approaches** by helping students to achieve higher levels in problem solving competence.



**Figure 2.1:** The overall Assessment Framework for monitoring the Open School Hubs development during the OSOS project implementation.

<sup>1</sup> The overall organisational and pedagogical framework of the OSOS Open Schooling Model is described in Chapter 3 of D2.1.

OSOS project is proposing several organisational changes with main focus on the introduction of the RRI methods in school practices. The main outcome of the proposed intervention is expected to be the development of student-led initiatives and projects that are focusing on local needs and key challenges the local communities are dealing with. Designing a framework for the implementation of such activities is not a simple task in current school environments. So, OSOS project has to deal with significant challenges in introducing a substantial change to the pilot school environments as well as on the pedagogy and the relative contents used in their practices. At the same time, taking advantage from the large scale implementation work the project team aims to assess the sustainability of such an intervention taking into account financial and cultural issues. The project team will study also how the current school based infrastructures (supported by social platforms and tools like the ones offered by the Inspiring Science Education services) could facilitate the foreseen transformation process. In the following paragraphs we are describing the different axes of the proposed framework in detail.

## **2.2 Rethinking how schools work**

### **2.2.1 Measuring Organisational Change**

Looking inside an organisation like a school unit, you can identify several functions or subsystems. These internal functions (or operations), have similar characteristics as the whole system. To manage and monitor the whole system a good feedback mechanism is needed. One that not only gathers information on how the system works but also interprets and reacts to the internal and the external feedback so as to keep the balance in the Organisation. The intelligent use of feedback is at the heart of what has begun to be called the Learning Organisation (see D2.1). This is the heart of the OSOS proposed framework. The School should operate as a learning organisation and improve according to the specific OSOS criteria.

The scope of the Impact Assessment Methodology is to monitor the Open Schooling Model's processes (strategies) and to provide the results on how this model is performing in order to identify specific strategies and tools for the school management uptake. Following the proposed strategies, we are expecting to increase the performance of the school at different levels. Within the scope of the OSOS project the project team is going to look at three levels of improvement of the school's organisational change (performance), the Management Level, The Process Level and the Teachers' Professional Development Level.

**Management Level:** This level refers to the school management. It describes how the school works or should work following the specific strategies (proposed by OSOS, D2.2), setting goals, developing a common vision, monitoring the overall process, introducing reflective procedures and adopting the strategy based on the feedback received as well as managing the resources available.

**Process Level:** This level refers to the processes and the activities that the school is implementing in the framework of the project and beyond. In this level the project team will monitor if the school is using the proposed pedagogical methods and the community building tools offered by the project. The outcomes of the assessment here could also inform the project team on how to develop services that could facilitate the school transformation process more effectively.

**Teachers' Professional Development Level:** This level refers to the opportunities for professional development (PD) that the school as an organisation is offering. The project team will examine if these PD activities are focused and systematic, if innovative approaches are used, if the school is taking advantage of external opportunities like the ERASMUS+ and eTwinning programmes to secure funding for teachers PD, if the knowledge gained through these activities is shared among the members of the school community and if the school has established mechanism to assess the impact of these activities to everyday teaching.

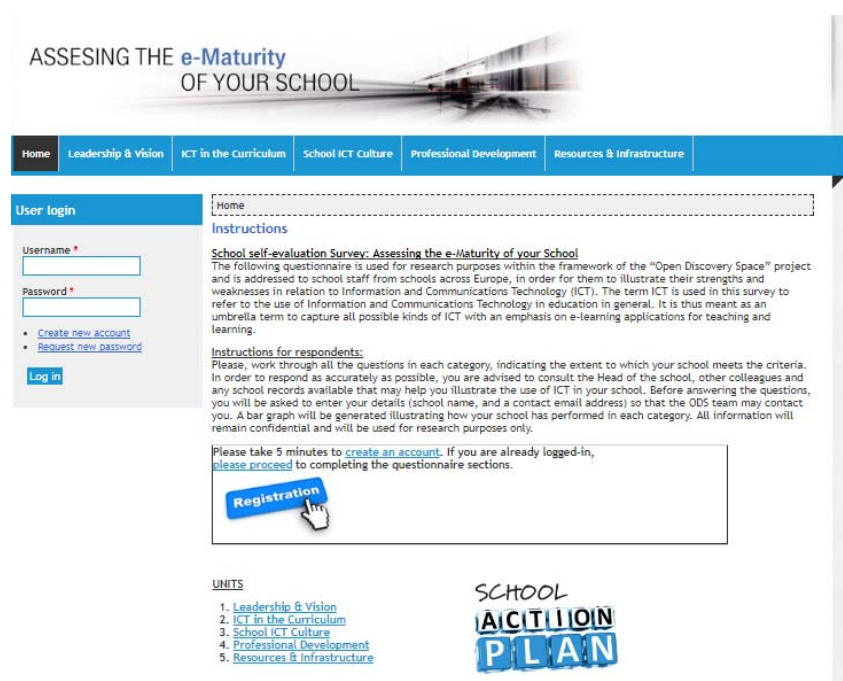
The effectiveness at each level and the overall school improvement has to be assessed through three crucial criteria:

**Goals:** In each of the levels, goals are needed to be set following the OSOS strategies. According to the D2.2 each school should develop a specific plan (School Development Plan) and follow it. Within this plan the goals for each school will be described.

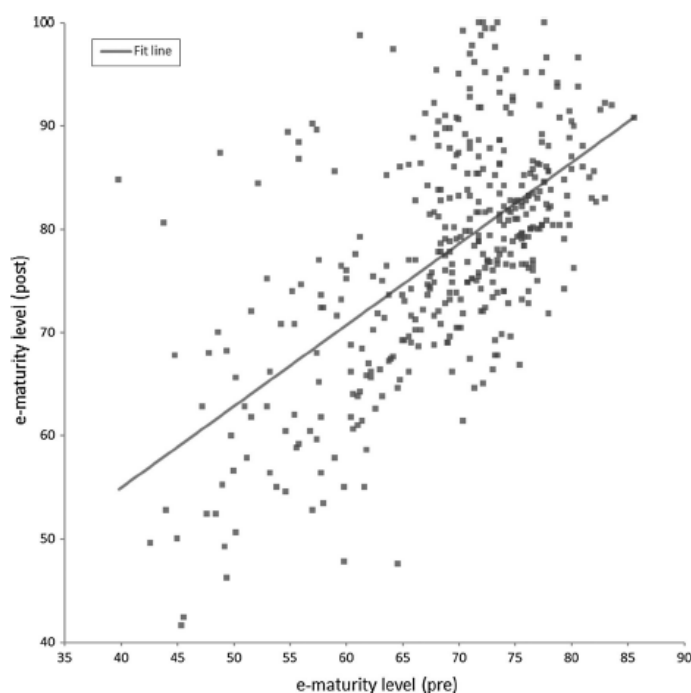
**Design:** In order to achieve the goals that will be set a specific design of their processes should be also exist. Depending on the school “openness” (based on the scores of the self-reflective school questionnaire – D6.2) according to the OSOS Strategies each school should design or update its approach so to maximize the impact.

**Feedback:** The achievement of the goals and the realisation of the school development plan consists a major milestone in the transformation process. A devoted instrument will be developed to help the schools to assess the level of the realisation of their development plans and to set new challenges in their transformation efforts.

The data that will form the overall score of each school will be collected through several tools that will be presented in the D6.2. In D6.2 the specific contribution of each one of the indicators will be presented so to provide the information on how the OSOS Assessment Methodology will measure the effectiveness of the proposed process and the Open Schooling Competence for every school. OSOS project team will develop self-assessment tool to help schools' progress towards openness and growth. The approach is based on a similar method that have been used in the framework of the large-scale policy support action Open Discovery Space (<http://e-mature.ea.gr/> see Figure 2.2). This approach has been also adopted recently by the Joint Research Center in collaboration with the Directorate General for Education, Youth, Sport and Culture (DG EAC) for the development of the SELFIE self-assessment tool for digitally capable schools. It is made up of 74 descriptors validated so far by experts, stakeholders and policy makers. SELFIE (to be launched in December 2017) aims to support European schools who want to reflect on their take up of digital technologies for better learning outcomes. The idea is that, every year, schools reflect on their current take up of digital technologies for innovative and effective learning by taking a snapshot of where they stand and then reflect and decide how they want to improve for the next year. Figure 2.3 presents the results from 1200 schools that participated in the Open Discovery Space pilots in 2015.



**Figure 2.2:** The entrance point to the Open Discovery Space e-maturity tool for schools. The focus areas are Leadership & Vision, ICT in the Curriculum, School ICT Culture, Professional Development and Resources - Infrastructure.



**Figure 2.3:** The e-maturity self-reflection tool assessing change/impact was completed by  $N = 1200$  schools in 2015. An increase in the e-maturity scores of 955 schools was recorded, while in 45 lowered scores were observed. Results from all e-maturity questionnaires show an increase of 8.61 % in the digital maturity of schools after 1 year (Sotiriou et al, 2016). The OSOS project team will adopt a similar approach and will assess the performance of the pilot schools according to the Open Schooling Competence Framework.

Following a similar approach, the OSOS project team will develop the “**Open Schooling Competence Framework**” which will be analytically described in D6.2. The Open Schooling Framework includes 40 key indicators for the school openness which are described in Chapter 3. The focus of the proposed framework will be to support schools to introduce an open culture in their settings. Through the use of the Open Schooling self-reflection tool the project team would like to facilitate (and celebrate) progress, not excellence. In other words, not each school can be/should be at the highest level in all openness indicators. Self-evaluation allows for understanding each school’s strengths and weaknesses and planning for improvement while the basic assumption behind the use of the proposed approach is that an open schooling environment that promotes deeper learning follows both top-down and bottom-up innovation and it is responsive and supportive of the development of its members and to its community. Finally, the aim of the project team is not to follow an 'one-size-fits-all' approach, but to propose a tool that will be fully customisable to the needs of the participating schools.

### 2.2.2 RRI Integration

The OSOS Assessment Methodology is focusing on assessing the RRI integration in school settings. There is a focused movement to reinvent the traditional classroom paradigm and rearrange the entire school experience — a trend that is largely being driven by the influence of innovative learning approaches. Methods such as project based and inquiry learning (Sotiriou & Bogner 2011, Sotiriou et al, 2017) call for school structures that enable students to move from one learning activity to another more organically, removing the limitations of the traditional timetable. The multidisciplinary nature of these contemporary approaches has popularised the creative application of technology and fostered innovative designs of school models that link each class and subject matter to one another. As learning becomes more fluid and student-centered, some teachers and administrators believe that schedules should be more flexible to allow opportunities for authentic learning to take place and ample room for independent study. Changing how learning takes place in classrooms is also requiring shifts in the business models of schools, which are increasingly becoming more agile and open to trying new approaches.

For an Open School to foster and mainstream the RRI principles within the organisation itself it will have to put in motion a number of specific guidelines and arrangements (**RRI Key: Governance**). The arrangements will refer to both internal measures in order to address RRI as well measures that will manage the interaction with other stakeholders in a more inclusive and responsive way. The Open



School will need to consciously institutionalise responsible practices and link with the local community societal needs. At the same time change needs to engage students in the educational process more effectively. The overall aim (through the implementation of inquiry and project based approaches) is to demonstrate a shift from students as consumers to students as creators of content. Additionally, the process should include all stakeholders who can share the responsibility for students learning (**RRI Key: Engagement**). The Open School needs to give to all the actors the opportunity to co-design the processes of change. The school should produce a gender equality plan (**RRI Key: Gender Equality**) and to involve all students in the process. The plan will address issues of gender inclusion in the level of the organisation structure as a whole, in the level of interaction among the educational staff and students and among students too. School practices should take place with no discrimination and following an ethical agenda (**RRI Key: Ethics**). A major issue during the implementation of the project is the process of sharing the developed projects. Usually teachers are not sharing their work although they are keen in using already existing educational materials. In an Open School this culture of sharing has to be the norm, while the overall process should allow teachers and students to have access to scientific data and resources without restrictions (**RRI Key: Open Access**). Emerging instructional frameworks are encouraging teachers to use digital tools that foster creativity along with production skills. This trend also implies that teachers are increasingly becoming creators, too, and are therefore in the position to lead activities that involve developing and publishing educational content. The OSOS Platform will provide the means and the tools along with the necessary collaborative and personalization functionalities to introduce learners in extended episodes of deep STEM learning related activities (**RRI Key: Science Education**). The assessment team will assess the sustainability of the proposed framework (**RRI Key: Sustainability**). Is the school able to operate under the proposed changes? Is it possible to afford these changes in terms of budget? What are the socioeconomic factors that might delay this change? Which might be the differences between countries?

The role of research and innovation (R&I) involves every key stakeholder (including policy-makers, researchers, industry and commerce, science educators, and Civil Society Organisations as well as the public at large). The large-scale Coordination Action RRI Tools has developed a series of tools that guide the introduction of RRI in different educational organisations both in formal and informal learning sector. The project has produced a handbook for schoolteachers (**along with a self-reflection tool for school**) with the main aim of accommodating Research and Innovation (R&I) practices in schools, and particularly in the teaching of STEM disciplines (RRI-Tools, 2016). The specific tool is developed in an iterative design process, from firstly desk research to several events with RRI experts, and different stakeholder groups that were hold specifically for the development and validation of the self-reflection tool (<http://www.rri-tools.eu/self-reflection-tool>).

The **RRI Tools self-reflection tool** guides your reflection by providing questions organized according to the RRI Policy Agendas: Ethics, Gender Equality, Governance, Open Access, Public Engagement and Science Education. The questions and their sample answers help you consider all relevant stakeholder groups (policy makers, education representatives, civil society organisations, industry and business, and the research community). Through a series of steps school heads could develop an RRI Development Plan for their schools: a) Register to start your reflection process. b) Select a policy agenda for reflection. Each agenda offers up to ten questions (displayed on the left). c) Choose the questions most relevant for your work: tick those that fit your situation, or untick those that do not. d) Enter your answers, remarks and considerations for each question in the open field located to the right of the questions. Sample answers are provided to help get you started. Tailor your personal questionnaire by adding your own questions specific to your practice. Jump to another question or policy agenda at any time. Your results will be saved permanently. e) Click on the Finish Self-Reflection button when you are done and download a PDF of your school self-reflection and use it to

How is research integrity addressed in your environment?	Which role do ethical committees play in your organization?
Whom do you involve in ethical reflection and decision-making?	People have different values, interests and ideals. How do you deal with that?

further reflect on your questions and answers, perhaps with your school team. f) At the last page you will also be offered to download an RRI Development Plan template to help you structure your RRI implementation.

Even if up to now, the RRI integration has not been assessed with specific criteria in order to give specific results of the level of the integration, in OSOS we will follow an assessment that will identify the level of each school's competence. Hence, OSOS will try to move beyond the existing RRI evaluation processes and will introduce the RRI integration indicators to the Open Schooling Competence Framework.

In the OSOS project, all the participating schools will fill-in at the beginning of each pilot phase the self-assessment questionnaire. A report will be produced for each school according to their answers. After each pilot phase, the schools will have to fill in again the self-assessment questionnaire so to provide the data for a comparative analysis.

### 2.2.3 Sustainability Assessment - economy and local budgets

The OSOS approach requires **extended organisation change in school settings** but at the same time the overall open schooling concept asks for **organisational change in other settings, like museums and research centres as well as industries** as they will need to cope with increased demands of outreach activities in the framework of their existing business models. So in the framework of OSOS project the aim is to investigate how schools can afford this organisational change taking into account the existing budgets and services offered. Are there any obstacles concerning the cost of the change? Is it feasible for all the participating schools to afford the cost for such changes? Do cultural aspects play a role in this? How each school and within its environment could implement the proposed approaches? Are the same conditions in all the countries? Are the external stakeholders ready to support these initiatives beyond the pilot phase?

The project team will follow closely the schools' stories of transformation and will try to identify potential sources of external funding or the implementation of cost effective models that will help school to realise their plans. The project team will assess possible norms and trends in this direction in order to come up with a series of proposed paths that many schools could follow in the future. Here different instruments (questionnaires, focus groups) as well as interviews with external stakeholders will be implemented and realised. The project team will gather data and conduct an analysis concerning the economic parameters as well as the cultural. The OSOS project will do this **through defining indicators around adding value to the Open Schooling activities**.

The first aim is to establish, in a separate way, a sense of value to be attributed (valuation) in schools' networks that arise through the OSOS model and then to assess the performances based on that value (evaluation). We acknowledge the ethos of RRI here and the general philosophy of education: the "value" or "worth" cannot be financial only. In higher education, the National Coordinating Centre for Public Engagement (NCCPE) adopted a system known in Harvard Business School as 'Socially Modified Economic Valuation' (SMEV) (Kelly and McNicoll, 2011). This approach is output-based rather than process- or outcome-based. While assessing outcomes and impacts is the broader objective of the OSOS Assessment Methodology, outputs are definable entities for metrics that can have cultural and societal import. Again, it is about setting a value on a cultural or community contribution. It follows many management theories of change and logic model approaches. The standard assumption is derived from the equation economic value = quantity x economic price. The addition of SMEV to the formula asks: "Which are society's desired outcomes?". OSOS in its assessment tools will set social weightings depending on the cultural context. So, for example, school classes with higher-than average remedial support, or that might have socioeconomic disadvantage will be attributed a higher social weighting than a school with less call for remedial support or from a higher socioeconomic area (validated through deliberation with a national education system and by the international literature). Other social weightings would include class and school sizes; regional amenities, proximity of

enterprise; national science policy priorities. These values add to a bigger picture of assessing science capital.

The concept of **science capital** can be imagined like a ‘holdall’, or bag, containing all the science-related knowledge, attitudes, experiences and resources that you acquire through life. It includes what science



you know, how you think about science (your attitudes and dispositions), who you know (e.g. if your parents are very interested in science) and what sort of everyday engagement you have with science. From research analyses, eight dimensions of science capital that together comprise what you know, how you think, who you know, and what you do, have been identified: 1. Scientific Literacy 2. Science-related attitudes, values and dispositions 3. Knowledge about the transferability of science 4. Science media consumption 5.

Participation in out-of-school science learning contexts 6. Family science skills, knowledge and qualifications 7. Knowing people in science-related roles 8. Talking about science in everyday life.

The second sustainability valuation aim has financial nature and can be implemented alongside the SMEV value - to investigate how schools can afford this organisational change following the Open Schooling Model. Are there any obstacles concerning the cost of the change? Is it feasible for all the participating schools to afford the cost for such changes? Do cultural aspects play a role in this? How each school and within its environment could implement the proposed approaches? Are the same conditions in all the countries? What are the differences between the countries that will participate in the pilot phase? These are some of the questions that must be answered during and after the pilot phases of the of the project. Within the OSOS project, the following are going to be analyzed:

- **The cost and social value** related to the implementation of the proposed approaches. Each school has specific budget for the operation. It need to be monitored how the schools will implement the proposed approaches in order to achieve the strategic goals of the Open Schooling Model. If it will not be feasible for the schools to implement due to budget/cost limitations it is needed to investigate alternative approaches to propose so to achieve the same scope. We use the Harvard-approved SMEV model to assess this social weighting aligned with and presented alongside actual costings of, for example, lab experiments, outreach programmes, meetings with stakeholders,
- **The community and the cultural conditions in which the school is operating.** The pilots are going to be realised in 11 countries, so it is important to gather data and provide a comparative analysis of the countries.

## 2.3 Shift from Students as Consumers to Creators

According to the NMC HORIZON Report 2015 K-12 “a shift is taking place in schools all over the world as learners are exploring subject matter through the act of creation rather than the consumption of content”. Today a vast array of digital applications is available to support this transformation in K-12 education; indeed, the growing accessibility of mobile technologies is giving rise to a whole new level of comfort with producing media and prototypes. Many Educators believe that honing these skills in learners can lead to deeply engaging learning experiences in which learners become the authorities on subjects through **investigation, storytelling, and production**. The OSOS project will have a significant contribution in this trend. The OSOS Platform will provide the means and the tools along with the necessary collaborative and personalization functionalities to introduce learners in extended episodes of deep STEM learning related activities. The platform will introduce learners in a **progressive exploration of scientific issues**. As learners become more active producers and publishers of educational resources, intellectual property issues will become a key component to be discussed and explored further. It will explore some key characteristics of the related science pedagogy by focusing on **students’ motivation and interest**. Additionally, it aims to demonstrate that such an educational



environment (Open School) promotes **deeper learning approaches** by helping students to achieve higher levels in problem solving competence.

### 2.3.1 Motivation towards learning science

Motivation to learn science is often defined as ‘an internal state that arouses, directs, and sustains science-learning behaviour’ (Glynn, Brickman, Armstrong, & Taasobshirazi, 2011, p. 2). Motivation plays a big role in learning science, promoting academic success and provoking more help-seeking behaviours and commitment (Schunk, Pintrich, & Meece, 2008). For teachers (or lecturers), it is important to understand students’ lack of motivation, and how to counteract, for example, by providing assistance in self-assessment and goal setting (Pajares, 2002), or by increasing autonomy (Black & Deci, 2000). This implies the need for valid tools to assess motivation. Measurement of science motivation can also help in examining relations between motivational components and other factors like personality, academic performance or intelligence. The search for appropriate tools to measure science motivation is not new (for an overview, see Lovelace & Brickman, 2013). The most up-to-date questionnaire with high quality and simple language seems to be the **Science Motivation Questionnaire (SMQ/SMQ-II)** (Glynn, Taasobshirazi, & Brickman, 2009; Schumm & Bogner 2016), primarily developed for college courses to identify unmotivated students in order to address their special requirements (Glynn & Koballa, 2006). A multicomponent construct provided the frame for assessing science motivation (of college students), combining important motivational factors: intrinsic motivation in combination with personal relevance, extrinsic motivation differentiated in grade and career motivation as well as self-determination and self-efficacy (Glynn et al., 2009). The model itself was grounded on the social-cognitive theory of human learning (Bandura, 1986). Of the many motivational components linked to learning science (see Glynn & Koballa, 2006; Glynn et al., 2009; Schunk et al., 2008), extracted five factors, already mentioned above, as essential: Intrinsic motivation is the drive we feel when we do something because it is inherently interesting or enjoyable (Ryan & Deci, 2000).

A reward for performing an intrinsically motivated activity is the activity itself. Consequently, intrinsic motivation is regarded as an important factor influencing academic achievements; items in the SMQ-II refer to curiosity, interest, value and pleasure on science/science learning. When extrinsically motivated, we do something because it leads to a tangible outcome (Ryan & Deci, 2000). In a scholastic setting, concrete outcomes are grades, as short-term goals, and potential professions as long-term results of achievements during the school career. In these two extrinsic motivators, two opposite ends of a continuum were identified: the motive of doing something because we expect external compensation (e.g. good grade as reward) or because we endorse the value or utility of the extrinsic goal (e.g. better career options) (Ryan & Deci, 2000). Two further aspects are essential for understanding (intrinsic) motivation in the framework of OSOS project: the autonomy students feel in our acting and our perceived competence performing a task – self-determination and self-efficacy (Ryan & Deci, 2000). The self-determination theory takes into account the recurring finding that extrinsic rewards may weaken intrinsic motivation (Deci, Koestner, & Ryan, 1999; Deci & Ryan, 1985). In an educational context, this self-determination refers to the control a student perceives he has over his learning. The feeling of autonomy leads to positive impact on academic performance (Black & Deci, 2000) and is therefore interesting for research on science motivation with students. The SMQ-II items for assessing self-determination refer mostly to the effort and commitment students show in science classes (‘I study hard ... , I prepare well ... , I put enough effort ... , I spend a lot of time’) and are, in contrast to the items of the other subscales, connected to behaviour patterns associated with achievement behaviour. Self-efficacy is the individual’s perception of competence to accomplish separable tasks and attain certain results (Pajares, 1996). According to social-cognitive theory, we are more motivated to learn if we believe we can achieve the desired result (Bandura, 1986), whereas if we have low self-efficacy, we are afraid of difficult tasks because we have negative expectations and do not believe in our ability to manage the task (Glynn et al., 2009). Therefore, it is not surprising that, for example, Pajares (2002) postulates self-efficacy as a very strong predictor of academic

achievement. Furthermore, self-efficacy beliefs are also held responsible for influencing adolescents' career decisions (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001). Early studies applied the SMQ of 2009 with no adaptation in wording to younger age groups (e.g. Bryan, Glynn, & Kittleson, 2011 or Zeyer et al., 2013) and confirmed the SMQ or parts of it as applicable to secondary school students. As noted earlier, understanding of motivational aspects may lead to overcoming motivational barriers to learn science, since one aspect of Glynn's et al., (2011, p. 14) scale is to 'examine relationships between student's motivation and students' characteristics'. According to Rothstein, Paunonen, Rush, and King (1994), science motivation components and personality traits are considered to influence scholastic success, whereas science achievement is regarded as dependent on science motivation (e.g. Singh, Granville, & Dika, 2002). Since personality traits reveal what a person will do (e.g. Furnham & Chamorro-Premuzic, 2004), they should be especially related to action-oriented items of the SMQ-II.

### **2.3.2 Situational emotions (interest) in learning science**

Much of previous and current work on emotions (and especially on interest) is based on trait-survey studies (assuming that a given trait is a personality variable that is resistant to short and sudden changes) by using questionnaires in cross-sectional designs assessing, e.g. interest, across grades and school topics, often in retrospect.

In the framework of OSOS project, we are planning to use a concept that distinguishes between current situational emotions and biographically developed and enduring trait-emotions (Ulich & Mayring, 1992) as interest may fluctuate during a lesson (Palmer, 2009). The idea behind this distinction can be clarified by the following example: Pupils may experience a particular lesson, e.g. a hands-on lesson or a specific topic, as interesting even though they do not have a general interest in the subject itself (Randler et al., 2011). Here, the project team defines "situational emotions" as emotions that are sensitive to changes and that are not developed as a stable trait factor (as, e.g. general interest in a specific topic). Like many psychological variables, state and trait components exist simultaneously (Spielberger, Gorsuch, & Lushene, 1970). A central aspect of implementation and of treatments in learning studies is the need to assess situational emotions as some kind of moderating variables, because they are related to learning success. There were just very few approaches that measured situational emotions (see as examples, Gläser-Zikuda et al., 2005).

The main focus of the work in the framework of OSOS is to further modify a short scale to measure differences in emotions during learning processes and especially during the implementation of the OSOS students' projects; this specific scale is ideal for OSOS context as it is supposed to be applied in different educational settings, such as in out-of-school as well as in typical school settings, and from 5th grade up to university level, as well as in formal and informal learning environments. The short scale has its benefit because it is less time consuming and can be applied many times during an educational unit at the end of the activities. As there is a need to assess situational emotions as a moderating variable when implementing educational interventions and, because there are very few approaches that measure situational emotions (Gläser-Zikuda et al., 2005), the main focus of our study in this framework to investigate the reliability and validity of a short scale to measure situational emotions in different educational settings, in different schools, in different countries in the framework of OSOS project. For the purposes of the study the project team differentiated between a more cognitive-evaluative (satisfaction) and a more affective (joy) dimension in terms of the concept "well-being" (c.f., Strack, Argyle, & Schwarz, 1990; Mayring, 2009). Interest is defined as a specific subject-topic-relationship which specifically includes importance and utility (c.f., Hidi, Renninger & Krapp, 1992), and boredom is defined by the components lack of action and interest, as well as subject-related boredom (c.f. Bellebaum, 1990; Csikszentmihalyi & LeFevre, 1987). Well-being is more related to a subjective positive feeling during the lessons, while interest has a more cognitive orientation, and boredom finally is related to a lack of action and interest. Previous work assessed situational emotions immediately after school lessons by using different versions of a situational emotion scale (Gläser-Zikuda & Fuß, 2008; Randler et al. 2011).

In OSOS the project team will investigate the reliability and validity of a much shorter scale based on just three items for each of the dimensions; interest, well-being and boredom. **The resultant nine-item scale is easy to apply in most OSOS-related situations**, for example at the end of a school-based activity, at the end of project-work or after a field trip.

### 2.3.3 Shift to Deeper Learning Approaches

Deeper learning combines the **goals of standardised testing** with **soft skills** such as **mastering communication, collaboration, and self-directed learning**. The ultimate goal is to assess a student's performance through more than just test scores. Project-based learning and inquiry-based learning have proven their efficiency in fostering more active learning experiences, both inside and outside the classroom. As technologies, such as tablets and smartphones are more readily accepted in schools, Educators are leveraging these tools to connect the curriculum with real life applications. These approaches are decidedly more student-centered, allowing learners to take control of how they engage with a subject. In advance examples of this trend, learners are able to brainstorm solutions to pressing local and global problems and begin to implement them in their communities. OSOS project supports deeper learning in STEM by implementing **project-based, inquiry-based and collaborative learning** approaches in the framework of extended multidisciplinary activities that will result in the students' projects.

**Project-based Learning:** Project-based learning is a deeper learning approach that is seen as a way to address gaps in science education. Project-based learning is stated to have a number of benefits that can enhance teaching and learning; they include **providing real world relevance, longer retention and ability to apply knowledge of lessons learned, preparation for the 21<sup>st</sup> century work environment**, and exposure to **using technology to solve problems**. These are the main characteristics of the OSOS approach. In the framework of the project students will work in groups for an extended period in order to develop a story and to present it to their classroom or the school in the framework of an event. Students will use the platform collaboratively, they will design, construct their projects, they will take photos, they will collect data, they will organize out-of-school activities and surveys and they will interact with external experts and other local stakeholders to finalise their projects.

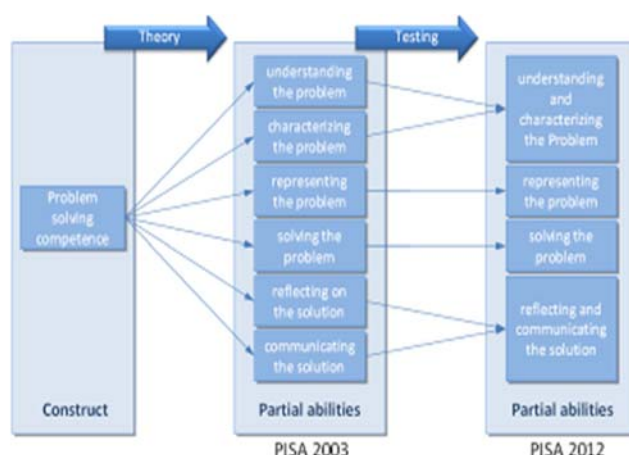
**Inquiry-based Learning:** Inquiry-based learning is proving to be an effective pedagogical approach to deeper understanding of curriculum. Inquiry-based learning involves learners constructing their own knowledge based on personal experiences and explorations. It is a method of learning by doing that parallels the work of scientists as they pursue scientific inquiry. With appropriate guidance, research has shown that inquiry-based activities can improve student learning in a range of subjects beyond STEM. By implementing the OSOS project teachers in the participating schools will formulate a classroom community of inquiry to show learners how to integrate technological resources to engage in new forms of communication and expression.

**Collaborative learning**, which refers to learners or Educators working together in peer-to-peer or group activities, is based on the perspective that learning is a social construct. The OSOS approach involves activities that are focused around four principles: **placing the learner at the center, emphasising interaction and doing, working in groups, and developing solutions to real-world problems** in the framework of the creation of the story. Collaborative learning models are proving successful in improving student engagement and achievement, especially for **low performing learners**.

In order to demonstrate the impact of the OSOS approach the project team will focus on describing the achievement levels in science based on the PISA 2012 Framework developed for the assessment of problem solving competence. This will offer the reference for validating the introduction of innovation in schools so that piloting and field testing results can be collated and analysed systematically and then disseminated widely, thus ensuring rapid impact and widespread uptake. Problem solving competence is a central objective within the educational programmes of many

countries (PISA, 2012). Classroom profiles during the problem-solving process will be compared and analyzed to demonstrate the impact of the intervention, following a global and standardized approach (see Figures 2.4-2.6).

**Figure 2.4:** The educational design of OSOS will focus on the assessment of the problem-solving competence following the PISA Framework. By developing inquiry experimentation scenarios (and the environment for their design and delivery) the consortium aims to measure the impact of the proposed intervention in comparison with the results of the PISA 2012.



## Modeling “Problem solving competence” in PISA

### Structure model

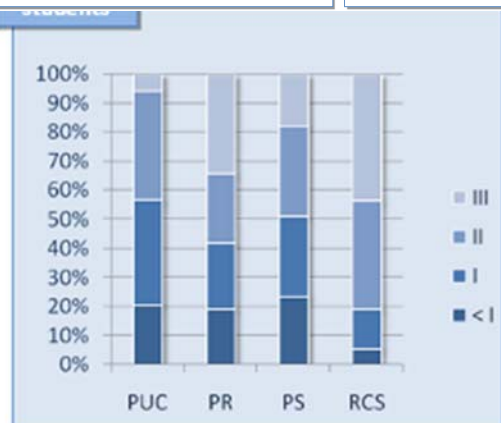
#### Problem solving process

1. Understand and characterize the problem
2. Represent of the problem
3. Solve the problem
4. Reflect and communicate the solution

### Level model

#### Student Levels

- III reflective and communicative problem solver
- II advanced problem solver
- I beginner problem solver
- < I no problem solver



**Figure 2.5:** The PISA 2012 assessment of problem solving competence is computer-based and interactivity of the student with the problem is a central component of the information gathered. The OSOS consortium aims to integrate the specific approach in the OSOS authoring environment to demonstrate the added value of the proposed intervention.

**Figure 2.6:** Classroom profiles during the problem-solving process: understanding and characterizing the problem (PUC), representing the problem (PR), solving the problem (PS), and reflecting and communicating the solution (RCS) (Koppelt and Tiemann, 2008). Such data from the OSOS classrooms will be compared and analysed to demonstrate the impact of the intervention, following a global and standardized approach.

### 3 Monitoring the Emergent Innovation in Schools - Assessment Indicators

#### 3.1 How to catalyse emergent innovation in schools (harnessing the social nature of innovation)

As has been mentioned in the previous sections of this deliverable, the OSOS project focuses on schools that are ready to set a plan to introduce innovations in their settings and to establish links to their communities and the world at-large, creating supporting networks (locally, nation-wide, Europe-wide and globally) on which to link (embed) the schools, and at the same time providing strategies and roadmaps. Following the OSOS school typology (presented in D2.2), schools can identify their level of readiness (phase) to adapt to an open schooling culture (stimulation phase, incubation phase, acceleration phase). For each school (and phase of its readiness) the OSOS approach can facilitate in an integrated way the “chain reaction” of school innovation and openness by providing the critical mass of innovative practitioners, engage them in communities of practice, support their work with numerous tools that will enrich their practices and provide them with systematic reflections on the impact of their interventions.

The OSOS support in guiding school dynamics toward an open schooling culture is essential in lowering the barriers to innovation. OSOS provides a crucial step toward innovation, however, in order for the innovation to take deep roots in the school and its community environment, the main points of the OSOS approach (connectivity/networks and adaptability to needs and expectations of the school and the local communities) must be implemented in the school’s “micro” scale, that is in the school’s local network. This “continuous innovation”, based not only on external forces but on “internal” generation at school and community level, is the ultimate aspiration of the OSOS project. This kind of “internally” generated innovation is called “organic” or “emergent” and is considered to be the most important innovation source not only in school environments but in competitive business environments and organisational settings in general. It is very crucial for the success of this intervention the OSOS team to provide schools with the necessary reflections to their efforts to innovate. In this chapter we describe the overall framework that the OSOS project aims to implement in this reflection process and we are presenting an extended list of indicators that will be used to define the “Open Schooling Competence Framework” which will be analytically described in D6.2.

Emergent innovation in school-community settings occurs when innovative, “entrepreneurial” teachers, staff, community leaders and citizens incubate and advance new ideas for addressing student and community needs and, thus, dynamically changing the educational conditions and the educational excellence and the contribution to the community (Oster, 2010). The important question for achieving the long-term OSOS outcomes is “how do we best connect teachers and schools and communities in ways that more systematically unleash emergent innovation?”, so that schools and communities “entangle” in constructive ways in a self-sufficient mode. In a recent work on how to catalyze innovation in organisations (Arena *et al*, 2017), the authors emphasise (a) the power of network structures and (b) the ability of organisations to create what they have termed *adaptive space* (Uhl-Bien and Arena, 2017).

The power of networks has been well documented in the management and organisational dynamics literature: many innovation programs fail to meet expectations, in part because they separate the innovation process from the informal networks needed to adapt and support an innovation (Cross *et al*, 2015; Cross *et al*, 2020; Johnson-Cramer *et al*, 2007) (this is particularly true in the case of obtaining innovation by [external] acquisition strategies that attempt to bring in new expertise and creative ideas, which make logical sense in their originating environment, but far too often underperform in the new environment due to integration challenges).

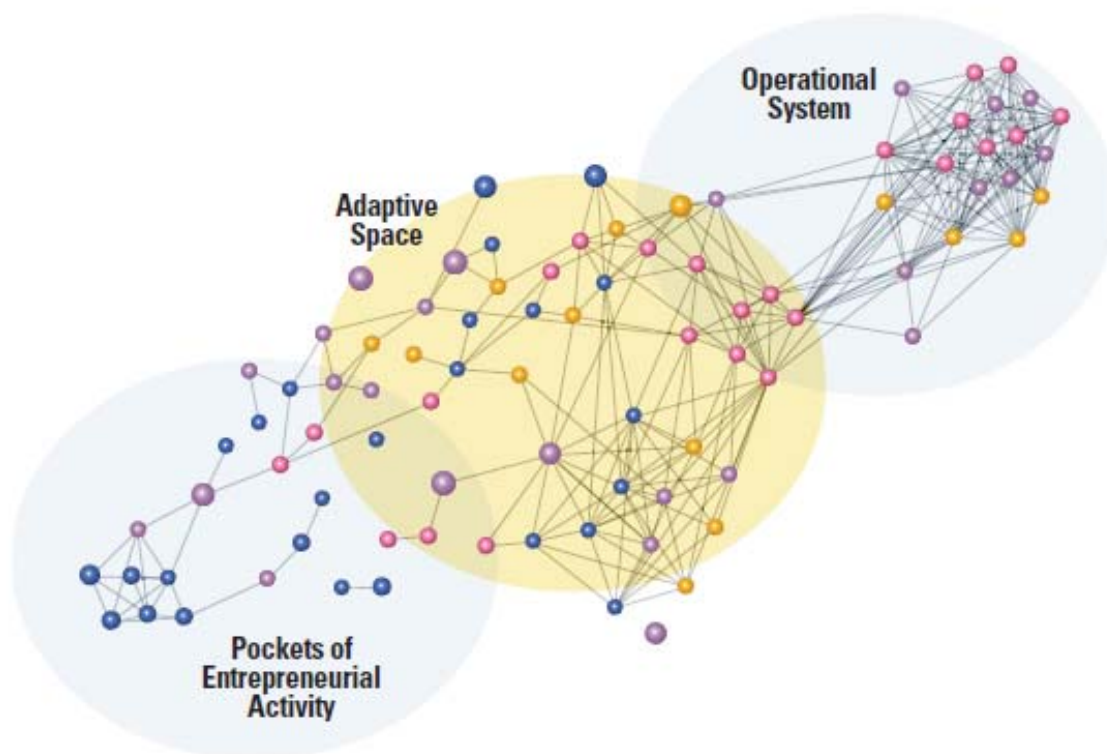
Arena *et al* (2017) define adaptive space as the network and organisational context that allows people, ideas, information, and resources to flow across the organisation and spur successful emergent innovation. As such, adaptive space facilitates the movement of innovative ideas and information





across a system. For school-community systems, it works by enabling ideas generated in “innovative / entrepreneurial pockets” of the system to flow into the “operational system” (that is, the formal system of the school), and develop into new approaches and learning modes that lead to better educational outcomes.

It is not a physical space but instead is any environment — such as a hackathon or internal crowdsourcing event — that creates an opportunity for ideas generated in innovative and entrepreneurial pockets of the school-community system to flow into the school’s operational (formal) system. The following diagram depicts the adaptive space “area”, which opens up information flows, enrich idea discovery, and carries the innovative/entrepreneurial activity from “pockets” to the “center” (that is, the operational, “formal” system of the organisation).



**Figure 3.1:** Depiction of the adaptive space “area”, which opens up information flows, enrich idea discovery, and carries the innovative/entrepreneurial activity from “pockets” to the “center” (that is, the operational, “formal” system) of the organisation (Source: Arena et al, 2017).

If adaptive space can serve as a “transportation network” to help facilitate the journey of the innovation from the “pockets” (concept) to the operational, “formal” system of the organisation (implementation), what are to the right (proper) network nodes for the innovation to “take roots” and get diffused efficiently to the rest of the system?

Using network analysis and data collected from organisations, Arena et al (2017) found that innovation leaders within an organisation engaged with experts, influencers, and decision-makers through different phases of an innovation’s journey, and in the process managed to substantially expand the impact of their innovation and streamline its acceptance as it moved from concept to implementation. They identified three network roles critical for emergent innovation, namely “brokers”, “central connectors”, and “energisers”, and how individuals can drive emergent innovation in adaptive space. The three network roles are depicted in Figure 3.2.

## KEY NETWORK ROLES: Implications for educational leadership's innovation efforts

In a recent research work (Arena et al, 2017) key network roles (brokers, central connectors, and energisers) have been identified in order to position innovators and to catalyze emergent innovation within an organisation.

**Brokers:** “Brokers build bridges from one group to another within and outside an organisation. As a result, they act as critical conduits of information and ideas. Specifically, brokers offer three competitive advantages to an organisation: broader access to diverse information, early access to new information, and control over the diffusion of the information. New insights usually arise at the intersection of existing networks. That is, as two heterogeneous groups connect, the potential for novelty increases. Brokers facilitate this discovery process through their social connections and then determine how and when these insights can be introduced to other parts of the organisation. The creation of adaptive space enables brokers to more actively connect and navigate beyond their local subgroups to explore new possibilities.”

**Central Connectors:** “While brokers are outstanding at finding ideas, they are not always best positioned to drive implementation. This is where group cohesion and central connectors play a critical role. Group cohesion represents how connected individuals are to one another within a group. A group is considered cohesive when many redundant connections exist among group members. That is, the likelihood of any individual within the group being connected to any other individual within the group is high. As a result, cohesive groups can quickly share information and generally operate with high levels of trust (Fleming et al, 2007). Connectors, especially those relatively central to cohesive groups, are essential to the development and implementation process. They are well-positioned to garner support for ideas from within a given group. Once introduced by a central connector, these ideas are easily diffused across the more tightly connected subgroup (Reagans and McEvily, 2003). Furthermore, the level of trust within these subgroups facilitates engagement with the ideas, learning, and risk-taking — all crucial components of creativity and development (Amabile et al, 2005). As a result, connectors can quickly drive local applications of ideas as well as future iterations for improvement. Innovation in a social context requires a thorough understanding of the interplay between brokers and connectors. This is why adaptive space is so critical: It helps position individuals within the network to drive progress. In large organisations, brokers often introduce ideas and central connectors develop them. Central connectors are often limited to insulated subgroups and therefore are likely to have their ideas dismissed by the larger organisation (Burt, 2004). Furthermore, cohesive groups are good at developing incremental innovations but rarely promote disruptive concepts (Battilana and Casciaro, 2013). Individuals within a cohesive group are less likely to take a major risk that could jeopardise their local group status. While the level of trust within these groups promotes risk-taking (and thus some forms of innovation), social acceptance limits the extent of these risks. The result: more, but safer, bets.”

**Energisers:** “Energisers help push people beyond the safe bets. In an organisational network, energisers may be brokers, central connectors, or simply other individuals who enthusiastically adopt an idea and promote it. Energisers trigger the interest and engagement of others and unleash the passion necessary for bold innovations to advance. Network energy, or enthusiasm, drives diffusion, co-creation, and active engagement across the larger organisation. It challenges people to think more boldly than they would within their own subgroups and creates a contagious mindset as the innovation progresses.” Energisers are able to fully engage in interactions, inspiring others to devote more time and energy to an initiative. The reputation of an energiser spreads quickly across the network, attracting others to aggregate multiple ideas into bolder, integrated concepts that are more likely to succeed. Energisers connect with individuals who have different expertise or backgrounds. These



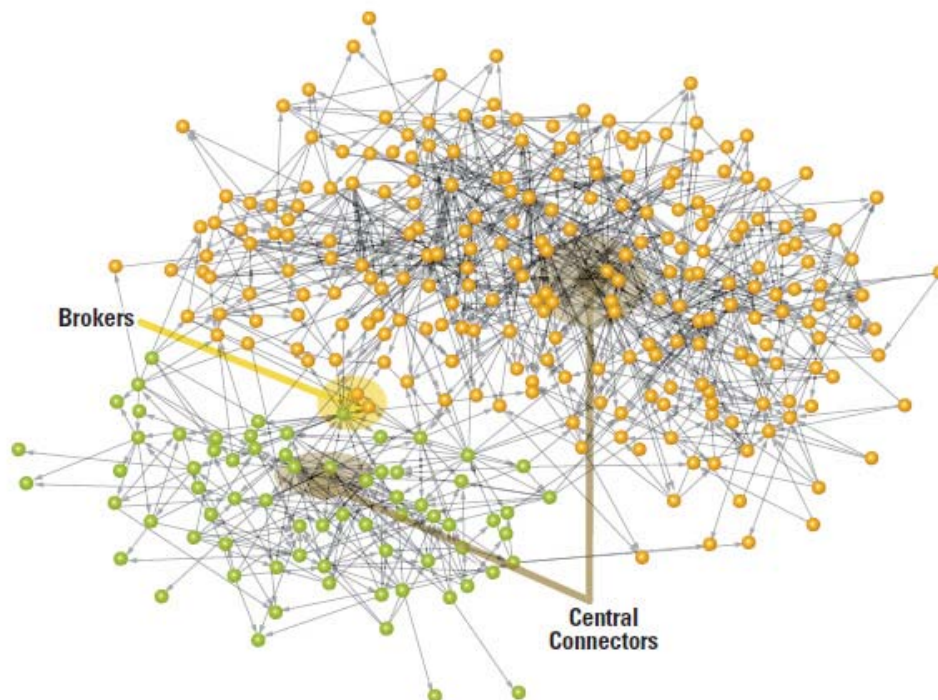
differences can be embraced as elements essential to the creation of bolder innovation. The result is the potential for new, more robust possibilities to emerge.

Working through key network roles has been found to be essential to successful outcomes (many good ideas never come to fruition because people do not have the formal or informal influence to get them into play). The social capital necessary for evoking emergent innovation is considered to be best represented by brokers, central connectors, and energisers, the roles of which are described in Table 3.1 (from Arena et al, 2017).

**Table 3.1: What Brokers, Central Connectors, and Energizers Do**

Brokers, central connectors, and energisers play important roles in successful innovation processes within large organisations. While brokers and central connectors represent distinct positions in a network, energisers can be anywhere in a network; they can be brokers, central connectors, or other individuals.

Brokers	Central Connectors	Energisers
Connect different groups in networks	Are well-connected in a subgroup	Can be anywhere in a network
Bridge silos	Get things done	Provide support
Explore and seek new ideas	Organise others	Inspire others to act
Have diverse perspectives	Serve as experts	Fully engage in the moment
Focus on many things	Quickly solve problems	Strive toward vision



**Figure 3.2:** The diagram represents information flows in a portion of the network within a unit of an organisation. The orange and green colors reflect two different sub-units of the organisation that should have been working more closely together — but the network diagram reveals that large-scale collaboration wasn't occurring between the groups. People who are well-connected within their subgroup are central connectors, while those whose connections span groups are brokers (Source: Arena et al, 2017).



Harnessing the social nature of innovation, it is very important for organisations, which want to become and stay innovative, to enable individuals to engage and connect in ways that trigger and expand ideas (de Jong et al, 2009) and to leverage organisational networks to allow innovation to emerge and be incorporated into the organisation's formal operational system (Uhl-Bien, 2009). Identifying network roles (by network mapping techniques) is an important approach but, however, it is not enough. Although such identification enables much more targeted innovation efforts, these efforts can take hold only if adaptive space exists to cultivate both the innovation *and* the network that generates it. Adaptive space is needed to connect these divided channels and allow ideas to advance from the entrepreneurial (informal) to the operational (formal) system. Such adaptive space allows for networked interactions to foster the creation of ideas, innovation, and learning (Arena et al, 2017).

### 3.2 Assessment Indicators

The OSOS evaluation team has prepared an extended list of indicators (40) in order to map the transformation process of the schools in the different phases of the implementation of the Open Schooling Model. The indicators are taking into account the different strategies that are proposed for the schools in D2.2. The list of the indicators was also discussed with the consortium partners in the framework of the consortium meeting (Bayreuth, 4<sup>th</sup> to 6<sup>th</sup> of October) during a workshop that was organised on this issue.

For each indicator the project team will need to define the data that have to be acquired, the methods and the tools that will be used for their acquisition and the overall contribution of the specific indicator to the overall openness process of the school. The aim is to support schools to develop effective partnerships with local stakeholders, to involve students in meaningful projects and activities and to increase the science capital of their communities. The layer of communal engagement is particularly important in terms of the societal level of the RRI framework. According to OSOS approach innovators need to be mutually responsive within and beyond their communities so the project team will explore the potential of the Open Schooling Hubs (100 schools) to share their practices through the development of a school network (with at least 9 more schools) that could have local, national or international character. The localized assessment approaches will estimate the impact on both, individuals and schools as an organisation, as well as on the development of effective cooperation with organisations like universities and research centres, informal learning centres (e.g. museums and science centres), enterprises, industries and the local communities.

The list of the indicators has been developed not only as a way to monitor the effectiveness of the OSOS Open Schooling Model but also as an extended check-list that can be used by the school management to monitor the process of innovation and openness at any stage or level of the intervention. In such a way specific corrective measures in well-defined areas could be implemented at any moment in order to improve the overall performance. Furthermore, the indicators (by following a progressive approach) could help the school management to identify drawbacks and obstacles in specific areas in order to provide solutions and further opportunities if necessary.

The proposed indicators are offering an integrated approach for the OSOS impact assessment. They describe numerous characteristics of the open schooling environment OSOS envisions. The most important issue though is that they are providing a holistic framework (starting from the school and management level till the learning outcomes of the individual student) that offers a general overview of the school's performance.

Table 3.2 presents the overall framework of the OSOS approach to develop a meaningful reflection process for the participating schools and their communities. It presents the OSOS Driving Forces and the mechanism to provide evidence for the successful implementation of the openness process in the pilot school settings (indicators and instruments to be used for data acquisition). Figure 3.3 presents the integrated assessment framework of the project.



**Table 3.2:** *The OSOS Driving Forces and the mechanism to provide evidence for the successful implementation of the openness process in the pilot school settings (indicators and instruments to be used for data acquisition).*

Driving Forces	Evidence of Openness and Growth	Indicators	Instruments to be used
Rethinking How Schools Work	Holistic school approach and vision	<ol style="list-style-type: none"> <li>1. <b>The school has a clear vision and strategy</b> towards open schooling</li> <li>2. At least one <b>appointed teacher with clearly defined actions</b> to support the open schooling strategy</li> <li>3. <b>Strategies</b> to encourage Problem Solving, Team Work, Active Citizenship, Critical Thinking and Gender Equality exist</li> <li>4. <b>Approaches aimed at replacing competitive type classroom</b> environment with more collaborative working approaches (that also addresses gender equality and inclusion) exist</li> <li>5. <b>Plans for professional development of teachers</b> for School Staff to foster a change in behaviour, enabling teachers to adapt to the open schooling culture</li> <li>6. Strategies for teachers to participate in <b>international mobility actions</b> are in place</li> <li>7. A <b>motivation mechanism is set-up for teachers/students undertaking innovative projects and social entrepreneurial behaviour. Brokers, central connectors, and energizers are getting in action.</b></li> <li>8. The school supports the development of an interdisciplinary environment where <b>students/teachers are encouraged try new ideas and approaches exists</b></li> <li>9. <b>Parental engagement is integrated</b> into the school planning structure</li> </ol>	<ul style="list-style-type: none"> <li>• Open School Development Plan</li> <li>• Open School Competence Framework</li> <li>• Self-Reflection Tool</li> <li>• RRI Self Reflection Tool</li> <li>• Questionnaires</li> <li>• Focus Groups and Interviews</li> <li>• Web Analytics</li> </ul>
	Effective introduction of RRI principles in the school operation	<ol style="list-style-type: none"> <li>10. School supports and introduces <b>student-led social enterprise start-ups community-focused courses</b></li> <li>11. School has an ongoing system of teacher and student self-reflection, discussion and learning set-up</li> <li>12. Teachers/students <b>engage in platforms for sharing best practice and lessons learned</b></li> <li>13. Schools set up a <b>system to reflect, track and monitor</b> how open school practices have shaped the school organisational culture</li> <li>14. <b>Parents actively collaborate</b> with the OSOS projects organised by the school</li> <li>15. There is a <b>commitment to changing the school at all levels</b></li> <li>16. Students and teachers incorporate a process of ongoing learning and evaluation into lessons and projects</li> <li>17. Students and teachers receive <b>feedback from community partners</b> and <b>adapt</b> projects, where possible, based on this feedback</li> </ol>	



		<p>18. Schools encourage and engage in <b>reflection, discussion and debates</b> on scientific and societal issues</p> <p>19. <b>All actors mutually benefit from the engagement</b> in the projects and incorporate learnings into their systems and processes i.e. Industry update their CSR/business strategy, there is an economic cost-benefit</p> <p>20. There is evidence of an <b>economic benefit-associated engagement</b> of all partners</p>	
	<b>Effective and sustainable partnerships with external stakeholders</b>	<p>21. School has a <b>system in place which captures the profiles, needs, contributions and relationships of all relevant external stakeholders</b></p> <p>22. Students identify and align stakeholder needs with <b>matters of local social and economic concern</b></p> <p>23. School actively <b>promotes the collaboration</b> with non-formal and informal education providers, enterprises and civil society organisations</p> <p>24. School <b>engages in a number of projects which demonstrate stakeholder inclusion</b></p> <p>25. School engages with outreach groups of research organisations to gain further <b>insight into the life and careers of scientists/engineers</b> (paying special attention into providing role models for all genders)</p> <p>26. There is evidence of <b>parental engagement in school projects</b></p> <p>27. Schools <b>increase the science capital of their communities</b></p> <p>28. Local/regional/national businesses and organisations <b>share their infrastructures and collaborate or work within the school projects</b></p> <p>29. School works with research centres and science museums to <b>develop initiatives using co-creative approaches, and vice versa</b></p> <p>30. <b>Visits to research centres, science centres and museums are becoming the norm</b></p> <p>31. <b>Formal procedures for stakeholder's involvement</b></p> <p>32. <b>Participation and engagement of policy makers</b> from key organisations in school projects and initiatives.</p>	
<b>Shift from Students as Consumers to Creators</b>	<b>Educational resources generated in school settings according the local needs</b>	<p>33. Schools show evidence of engaging in <b>virtual and physical platforms to develop new innovative projects, share ideas, identify and collaborate with other schools</b> to develop innovative projects aimed at addressing the grand societal challenges</p> <p>34. <b>Schools projects and activities are related</b> to issues of national or local interest in connection with the grand challenges</p> <p>35. Schools <b>share Open Schooling approaches with other schools and external agencies on regional and national levels</b></p> <p>36. Development of a <b>support infrastructure for teachers and students to organise local conferences, workshops, cafes, exhibitions open days</b> in the school with stakeholder involvement exists</p>	<ul style="list-style-type: none"> <li>• Questionnaires</li> <li>• Web Analytics</li> <li>• Open School Development Plan</li> </ul>



	<b>Increased Interest and Motivation</b>	37. <b>Positive impact on learning outcomes</b> – increased student motivation, increased interest in science, achievement of higher levels of problem solving competence and collaboration	<ul style="list-style-type: none"> <li>• Questionnaires (SMQ)</li> <li>• Questionnaires (IMI)</li> </ul>
	<b>Development of key skills</b>	38. <b>Positive impact on learning outcomes</b> – achievement of higher levels of proficiency in problem solving and collaboration skills	<ul style="list-style-type: none"> <li>• Web Analytics (Problem Solving Competence and Collaboration)</li> </ul>
	<b>Focused policy support actions</b>	39. The school is a <b>recognised site of shared science learning</b> in the community 40. Schools engage with <b>policy makers to inspire curriculum change</b>	<ul style="list-style-type: none"> <li>• Focus Groups and Interviews</li> </ul>

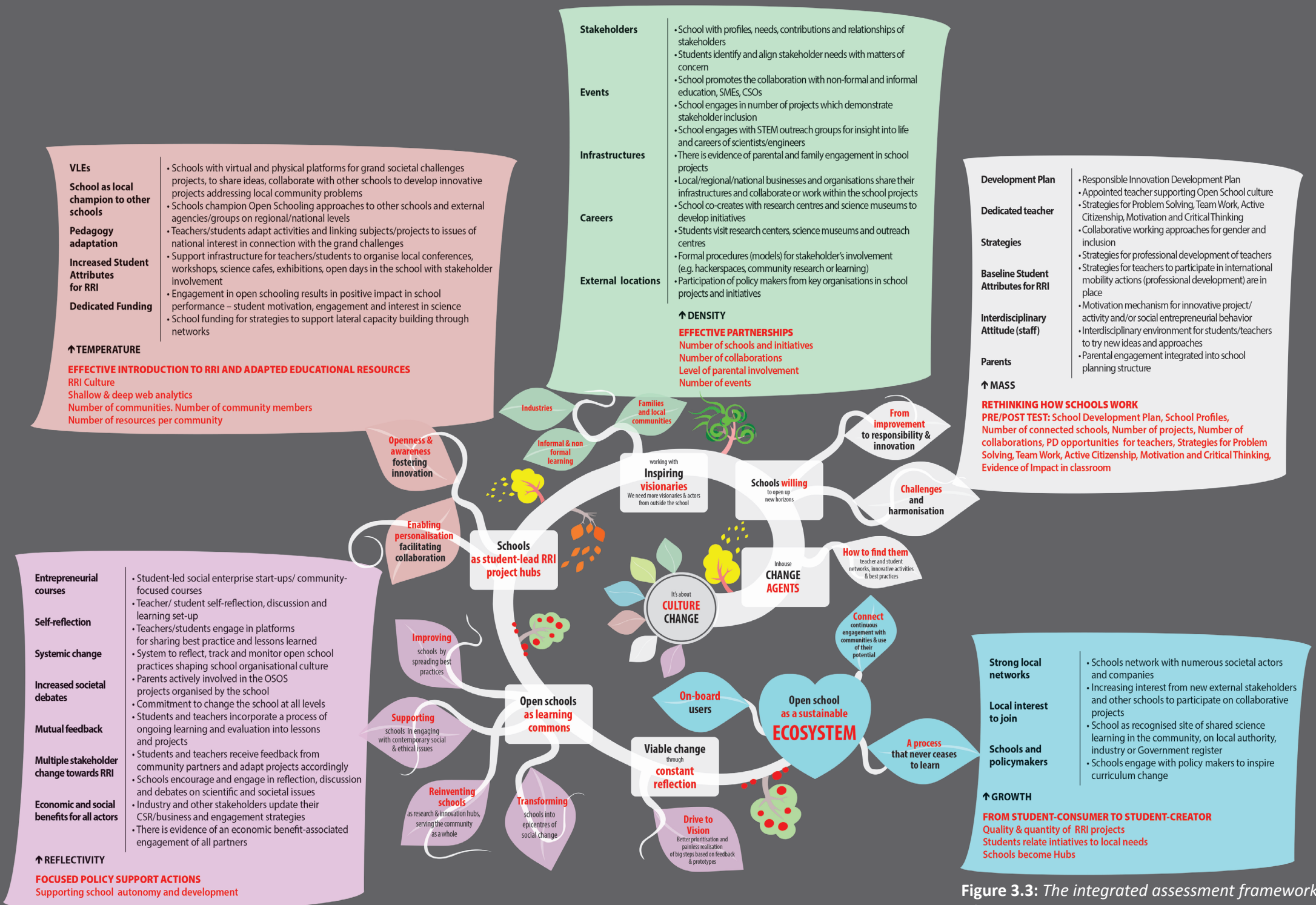


Figure 3.3: The integrated assessment framework of the OSOS project.

## 4 Assessment Tools

Different methods and techniques will be employed, including a mix of quantitative and qualitative methods such as document and statistical analysis, interviews, focus groups (during specific events like summers schools and workshops with the national coordinators), tracking of student interest/progression, online survey tools etc. To collect quantitative data an evaluation template with standardized questions and reflection points will be developed. Each OSOS National Coordinator and pilot hub contact point will populate the evaluation template and submit short quarterly reports. Data will then be analysed by the evaluation team capturing specific information such as the number of industry role models engaged, number of students engaged with industry, number of partnerships created. The collections of data through the questionnaires, interviews and focus groups is considered as direct data collections from the target groups while the web analytics is an indirect collection of data. In this Chapter we are describing the tools that will be used to populate the OSOS impact assessment database. We are also presenting numerous examples from the use of these tools in the framework of previous projects and initiatives.

### 4.1 Direct Data Collection Assessment Tools

In this section, we will discuss the reasons for using the School Development Plans along with a) questionnaires (including the Self-Reflection Tool for Schools) and b) interviews and focus group justifying the need for such triangulation method. The triangulation of methods strengthens the process of evaluation and will allow us to get more insight, overcome inadequacies of each method, verify / confirm findings from other methods and identify inconsistencies. Such triangulation can also apply when collecting secondary data where different types of documents and data sets complement and support each other.



Figure 4.1: Data collection methods to be used.

#### 4.1.1 Open School Development Plan

Pilot schools will be asked to cater for a holistic school development plan in using a provided template. That plans will provide a robust base for automating and facilitating the task of periodic school self-assessment based on reliable indicators, such as development of innovative projects and initiatives, school external collaborations, teachers' professional development plans and school portfolios that may also include information on teacher-generated content, effective parental engagement strategies. The proposed School Development Plan Template is presented in D2.2. It will be used in the framework of the first pilot phase and it will be tested in about 100 schools in different European countries. In the second pilot phase the tool will be used with all participating schools (in its final form).

#### 4.1.2 Questionnaires

Questionnaires will be used at various stages. The participants will receive standard questionnaires designed for specific aspects and indicators and will be used during open events, conferences and workshops. The main questionnaires will be used within the schools' activities so to capture mainly the motivation and interest of the students (see Chapter 3). While questionnaires are inexpensive, quick, and easy to analyse, they can often have inadequacies as a tool. For example, unlike interviews which





are described in the next section, with questionnaires one can never be sure that the respondent understood the question that was being asked. Also, because the questions can be very specific, the answers may yield minimal information or lead the participants to narrow topics.

#### **4.1.3 Interviews and focus groups**

Interviews are most appropriate where little is already known about the topic or where detailed insights are required from individual participants. They are also particularly appropriate for exploring sensitive topics, where participants may not want to talk about such issues in a group environment. While it is ideal to conduct an interview in person, the interviews in the context of OSOS project, will be mainly realised over skype calls or conference calls (using Adobe Connect). This method will be mainly realised with school heads and teachers. In case a workshop will be realised or a summer school then the interviews will take place in person. Before the interviews, respondents will be informed about the details and given assurance about ethical principles, such as anonymity and confidentiality. This will give respondents some idea of what to expect from the interview, increases the likelihood of honesty and is also a fundamental aspect of the informed consent process. Other ways to generate data include group discussions or focus groups. Advantages of focus groups include possibility of obtaining primary data through non-verbal channels, as well as, verbal channels and approaching the topic from various perspectives. The group dynamic can provide useful information that individual data collection does not provide. They are easy to set up and useful in gaining insight into a topic that may be more difficult to gather through other data collection methods. Just like any other research method, focus groups have some disadvantages as well. Group discussions may be heavily influenced by one or two dominant individuals in the group and some members of the focus group may be discouraged from participating in discussions due to lack of confidence or communication skills. Moreover, the nature of primary data obtained through focus groups are greatly influenced by environmental factors such as design of the room, room temperature, time of the day, etc. They can also be susceptible to facilitator bias and data analysis is time consuming. We also need to note that they do not provide valid information at the individual level and the information is not representative of other groups. Focus groups typically last about 60 to 90 minutes. The focus groups could be organised during national or local activities and could be facilitated by the OSOS National Coordinators. The design of focus group research will vary based on the research question being studied. A more detailed description of how the focus groups will be organised and the specific themes that will be discussed will be included in the D6.2.

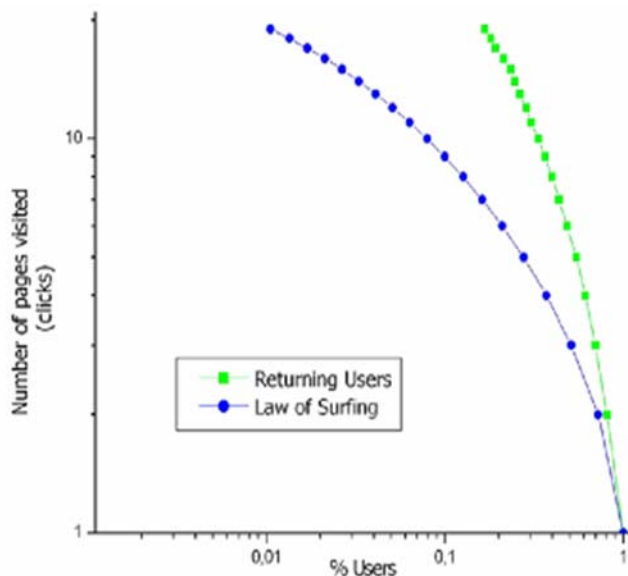
## **4.2 Indirect Data Collection Tools: Shallow and Deep Web Analytics**

In this section, we are presenting some indicative examples on shallow and deep analytics that could be provided from the OSOS platform to support students learning and achievement as well as the design of more effective educational experiences for the students. We will discuss the “Users Behaviour”, the “Time on Task”, the “Educational Value of the Resource”, the “Class Profile”, and the “Competence Proficiency”. The data which are used as examples are based on the work that has been done in the framework of the large-scale policy support action Inspiring Science Education and involves more than 10,000 data sets from students who were assigned with specific inquiries and they had to follow the full inquiry cycle. The assessment method for the Class Profile and the Competence Proficiency are based on the PISA approach for assessing the problem-solving competence as discussed above.

### **4.2.1 Users Behaviour**

The data that will be acquired from the use of the platform and its services create opportunities for the qualitative upgrade of both teaching and learning, heretofore unavailable, optimising the affordances of available resources across a range of diverse settings. In this framework evaluation metrics will be used to demonstrate the effectiveness of the proposed approach in the use of scientific resources that are available on the web. The work here will focus on *user paths* assuming that each user path

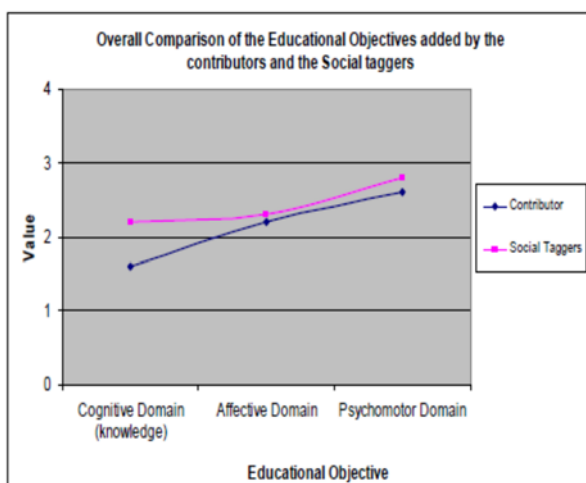
represents a user trying to accomplish a task. The temporal evolution of the number of contributors and the number of user-generated scenarios uploaded are also important parameters. Web metrics will be used to track users' behaviors (e.g. the users' loyalty of an educational Portal (portal.discoverthecosmos.eu), see Figure 4.2) including referring methods, search terms, technology use, page paths (number of visits, time spent on site), entry/exit pages, and geo-segmentation.



**Figure 4.2: Users Behavior:** Returning COSMOS Repository users show high levels of loyalty, stay longer on site, make more page views. They are benchmarked against the law of surfing (Huberman et al. 1998) and outperform it. About 15% of the COSMOS Portal users are visiting more than 20 pages per single visit. The graph presents the probability  $P(L)$  of the number of pages  $L$  that a user follows in the portal. This model was verified by comparing its predictions with detailed measurements of surfing patterns. These quantitative results indicate that the COSMOS portal exhibits patterns of offering substantial value to its users in the science education community (Sotiriou et al, 2011).

#### 4.2.2 Educational Value of Educational Resources

Compound metrics, such as ratios that combine 2 or more single metrics, will also be used for tracking visitor behavior. The data will be augmented with data associated with the usage context (classroom, science center, on the field) and the educational value of the resources used (for example by defining the educational objectives of an educational scenario and offering the opportunity to the users to assess its effectiveness in promoting the specific cognitive, affective or psychomotor objective determined by the contributor, see Figure 4.3). The data are from the use of the OpenScienceResources Portal that supports the development of educational pathways between formal and informal settings.



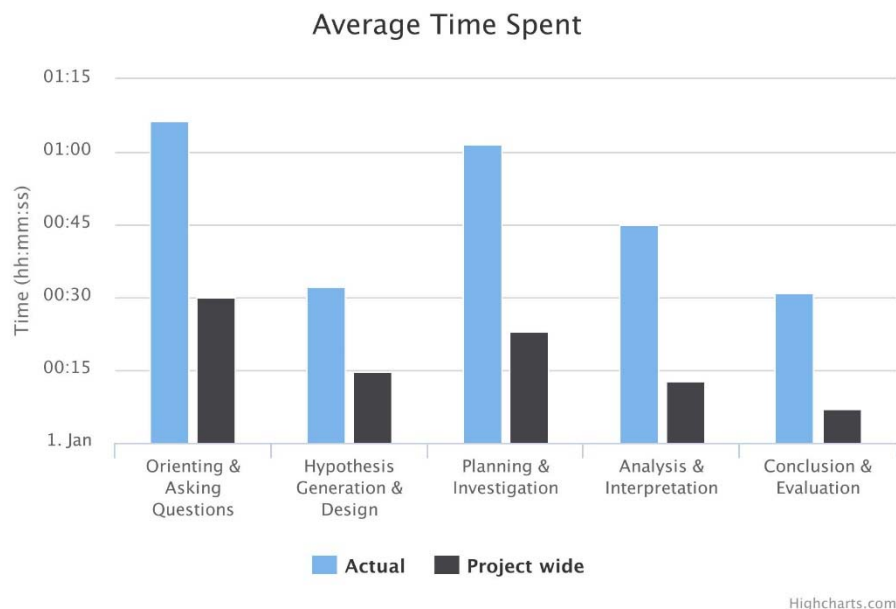
**Figure 4.3: Benchmarking the educational value of eLearning resources:** The OpenScienceResources consortium ([www.osrportal.eu](http://www.osrportal.eu)) has developed a classification system for the characterization of the educational objectives (based on Blooms Taxonomy) of the proposed activities and the users are capable to assess their experiences during their "paths" on the portal. The graph presents the overall comparison of the educational objectives assigned by the contributors with the values assigned by the social taggers, demonstrating the educational value of the materials of the repository according to the users' view.



### 4.2.3 Time-on-Task

Time on task is very important parameter in educational research. It is also considered relevant variable, which is correlated to students' learning and achievement (Hattie et al., 2012). Time on task is defined as the total time that students spend engaging in a task that is related to outcome measures of learning or achievement (Berliner et al., 1991). In this case time on task refers to the time that is spent within the specific phase of the activity. Based on the time-on-task paradigm, which is a simple but powerful framework to explain students' achievements it may be possible to draw conclusions about the effectiveness of the OSOS methodology. However, this paradigm does not only represent the time students spent on learning, but it also represents an academic commitment. The students show academic behaviour, they observe phenomena, draw conclusions, write reports or reflect on scientific questions. The time-on-task value indicates a change in their attitude and behaviour and is one of the most important factors influencing academic achievement (Marks 2000; Slavin 2003). Therefore, first insights in these constructs are possible by measuring the time of use of these resources.

As the main aim of the specific document is to provide examples on how the analytics could support the learning experience we are using as a reference data that were collected during the use of the Inspiring Science Education environment that offers the educators the facility to view the assessment results of their students, both individually and as a whole. Based on that, an analysis was done for several lesson implementations of different educational activities in various school environments in different European countries. The graph in Figure 4.4 is an example of the Inspiring Science Education statistics dashboard output for the average time spent per phase of a specific lesson. This data chart (presented as an example) was collected for the lesson: "Light: Reflection and Refraction". The chart gives a first overview of the average time spent by all students in all the 15 implementations (actual) for this lesson and compares it with the average time needed by all implementations in the participating countries (project-wide). A paired-samples t-test was conducted to compare the actual duration of the demonstrator and project-wide time. The t-test result showed that there is a significant difference in actual duration and the project-wide with  $t = 0,017$  ( $p < 0.05$ ).



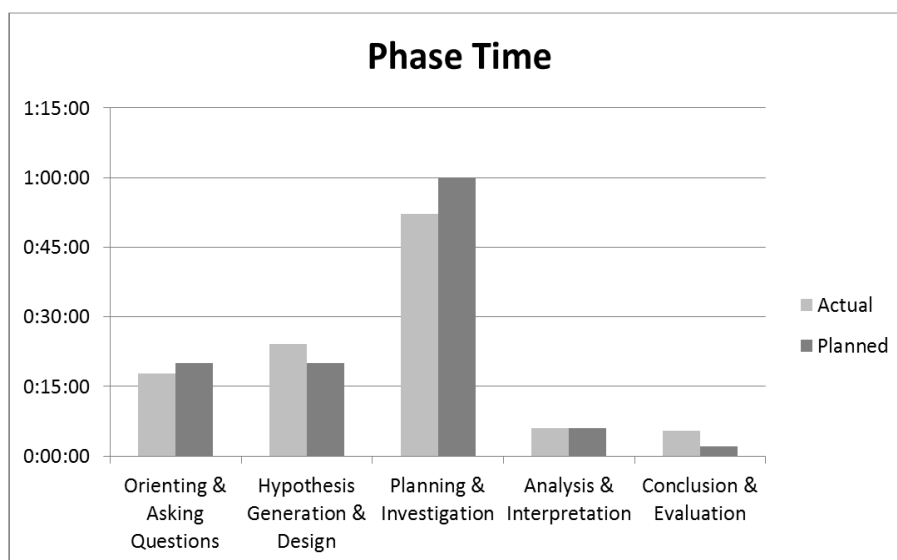
**Figure 4.4:** The average time spent per phase in "Light: Reflection and Refraction" lesson compared to the overall average time per phase. The data indicate that this is a time consuming and (maybe) a rather complex task for students.

A different way to use the specific information in the inquiry cycle is to perform comparisons between the expected (optimum) and the actual time devoted to each phase of the lesson. Here we are using as an example the data collected from the use of the HYPATIA virtual lab (Figure 4.5). This is a quite complex lab that introduces students in particle physics. In all four out of the five phases of the inquiry process the students actually spent less time than the one assigned to them (Figure 4.6). Only phase 4 (Analysis and Interpretation) exhibits a slightly different behaviour, even though the difference is within the accepted deviations. It is important to note that the most interactive phase of the lesson, and therefore the most demanding in terms of time, is phase 3 (Planning and Investigation). Ample time was given to the students in order to complete this phase and the results show that the time limits of the experimentation are reasonable and allow an easy implementation of the exercise in school, as far as the time limits are concerned.

**Figure 4.5:** HYPATIA is an innovative hands-on event visualization tool which aims to introduce students to the most modern particle physics research. It aims to stimulate students' interest with science by involving them to interactive analysis of data from the ATLAS experiment at CERN. The recent discovery of the Higgs boson has attracted large media coverage generating great public interest. The students, through the usage of HYPATIA, can try to "discover" the Higgs boson themselves.



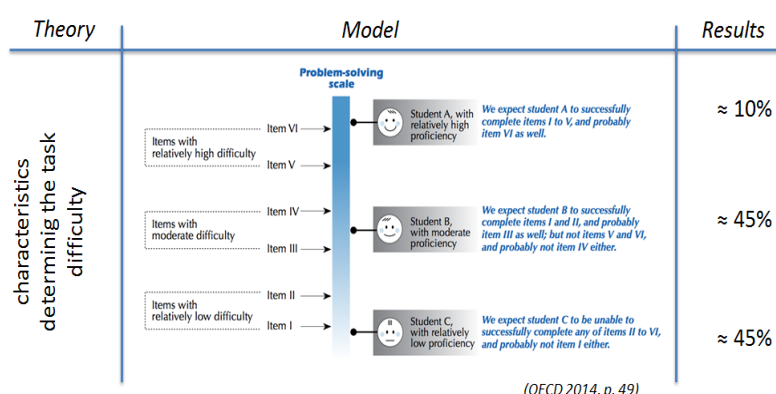
The overall time required for the completion of the complex activities of the HYPATIA virtual lab (understand the concepts, perform the experiment, analyse the results) is well under two hours, the time which is allocated to project work according to the Greek National Curriculum. The fact though is that such information can be very useful to the teachers in order to adopt their lessons accordingly so as to meet the optimum time that is usually provided by the developer/author of the educational activity.



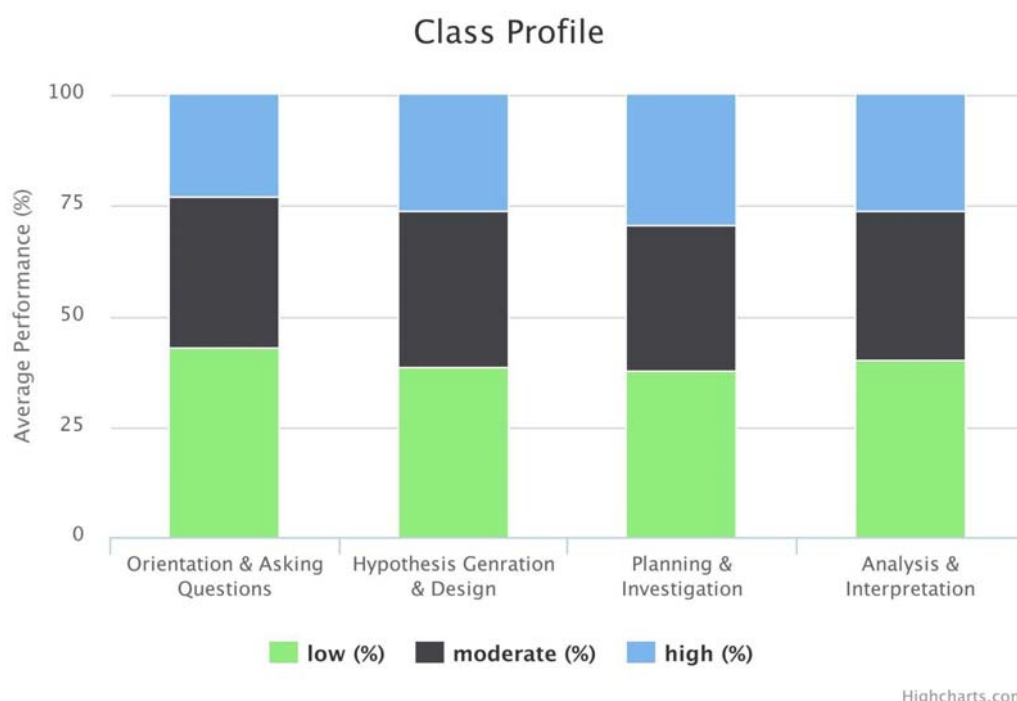
**Figure 4.6:** The average time spent per phase in "Looking for Higgs Boson" lesson (with the use of the HYPATIA virtual lab in phase 3) compared to the planned/proposed time per phase. The data indicate that the implementations were made according to the proposed inquiry approach.

#### 4.2.4 Class Profile

In this section, we are discussing the Class-Profile metric. Students are categorised in three categories according to PISA 2014 (see Figure 4.7). The Class-Profile is calculated by considering the lowest level task per phase for the completed task. Students (in the framework of the presented study have to solve two specific tasks that are connected with the specific partial ability). For example, if a student in the “Orienting & Asking question” phase completes successfully the two assigned tasks gets on a high level. In case the student is not able to solve neither of the tasks then his/her profile value will be on the low level in the orienting & ask phase. Moreover, if the student’s answers were high and moderate respectively, then his/her profile value will be moderate. By this procedure the specific study underestimates the real performance but such a process will minimize the risk for interpretations when comparisons are included. Further on the final percentages per class were calculated and presented in the dashboard as diagram shown in Figure 4.8 for all the inquiry phases and for all lessons in all countries (about 11,000 students’ data sets from about 600 lesson implementations).



**Figure 4.7:** Students categorisation according to PISA 2014 as far as their levels of proficiency in dealing with tasks of varying difficulty. On average OECD countries classrooms consist of 45% of students who show low proficiency, 45% with students with moderate proficiency and only 10% with students with high level of proficiency.

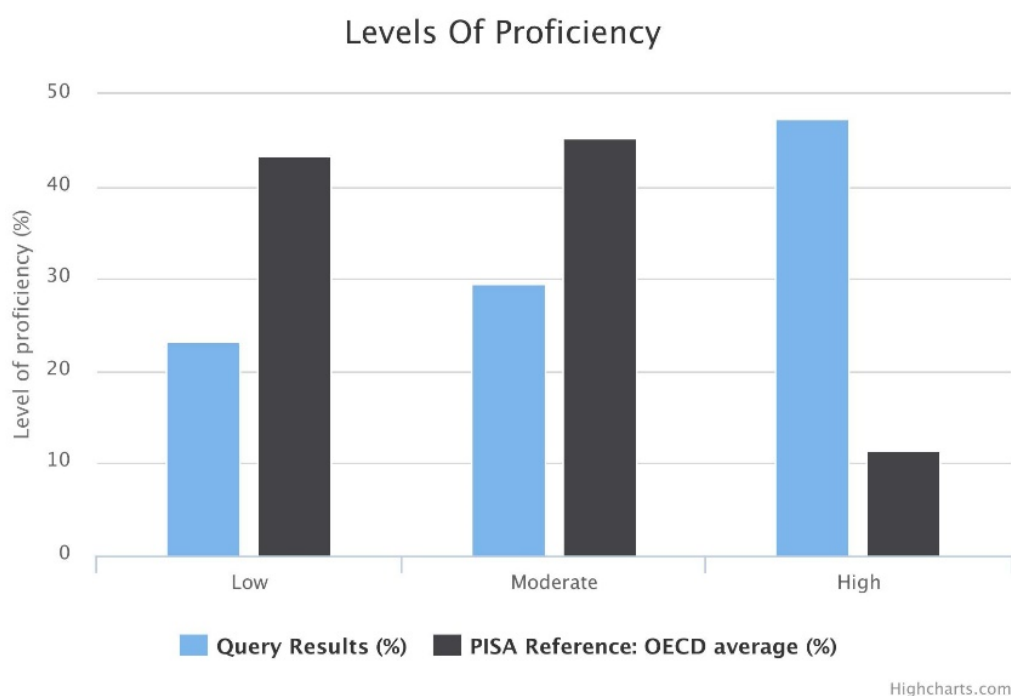


**Figure 4.8:** The average values high, moderate and low performer per phase of all students, for all implementations realised in the framework of Inspiring Science Education pilots.

On an empirical perspective, the problem-solving questions should be designed in a way that only 10% of the students answer on a high level, 45% on a moderate level and 45 % on a low level. In the specific case, the graph demonstrates that (for the specific sample) 25% students scored at the high level while the number of students scored at low level follow the empirical norm. We can claim, in such a case, that the specific approach is supporting students to develop from the moderate level to the high, but clearly the tools and the approaches used cannot have significant impact to low performers.

#### 4.2.5 Levels of Proficiency

The levels of proficiency could offer an opportunity to teachers for direct comparisons with country average or even OECD average scores. Additionally, the continuous use of such assessments from the teachers for the same class could act as a very effective method to monitor students' skills development. The results here are referring again to the same sample (11,000 students) and they are presented as the percentage of the total number of replies.



**Figure 4.9:** *The frequency of high, moderate and low levels of proficiency (%).*

The level of each task is added for every problem-solving question in the four phases and is then divided by the number of tasks. This method is offering the opportunity to have a clear view of the students' performance as there is no need to select among the task level when the student performance is not the same in the task of each phase. Then the percentage is calculated. The example of the average of High, moderate and low levels of proficiency calculation are presented in Figure 4.9 compared with OECD Average. The results are either compared with the average of all replies in the Inspiring Science Education study, or with the PISA standard. The findings demonstrate that the use of the system has helped students to outperform OECD average.

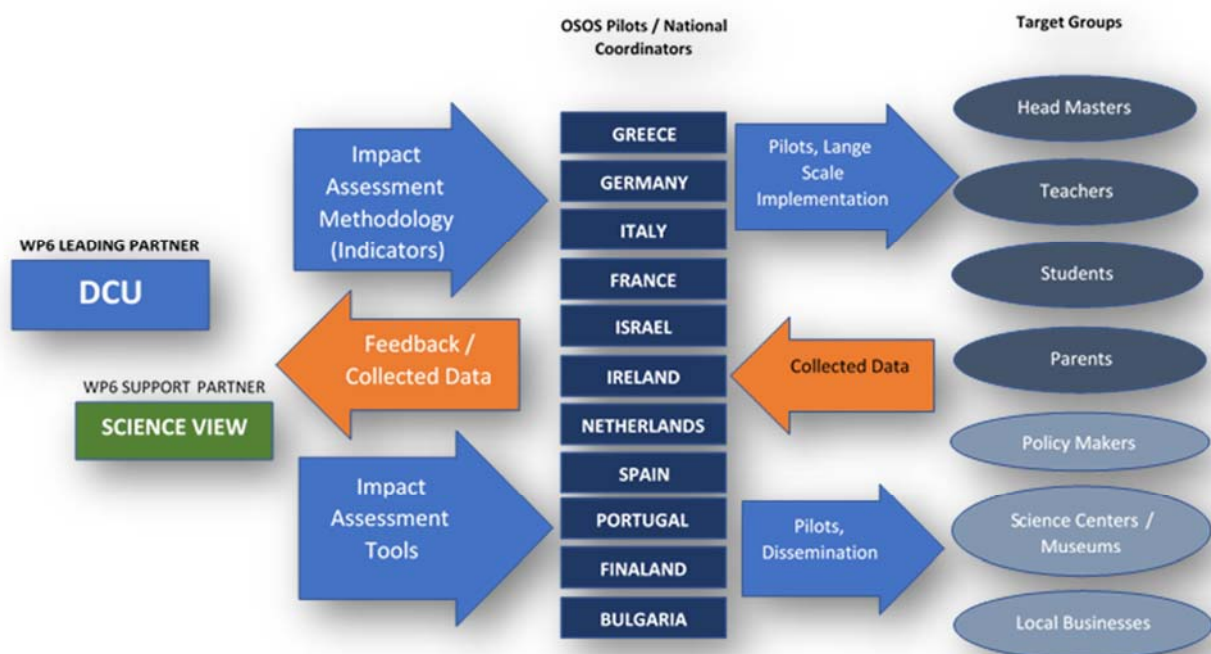
## 5 Participants involved in OSOS Impact Assessment Process

In this section, we describe the key actors of the Impact Assessment process that will be implemented in the framework of the work in WP6. Apart from the evaluation team and the technical team that will safeguard the availability of the web-based data samples the role of the National Coordinators is also crucial. In this short chapter we are presenting the role of the National Coordinators. Then we describe the target groups of the Impact Assessment process. Figure 5.1 illustrates the operation scheme that will be followed.

### 5.1 The National Coordinators

The main role of the National Coordinators in WP6 is to ensure the data will be correctly obtained and comparable all activities will have to implement the assessment following the same procedure. Additionally, the National Coordinators have the responsibility for the translation of the OSOS Impact Assessment instruments.

Each National Coordinator has to nominate a person in charge who will be familiar with the Impact Assessment Plan, the national conditions, the school settings involved and the validation protocol. Training workshops (both physical and virtual) will be carried out to instruct the National Coordinators on the assessment strategies and tools and to include their input to the localised assessment plans. The National Coordinator will also be responsible for developing the localised assessment plans and to adapt the tools and procedure respectively.



**Figure 5.1:** Target Groups and Data Flow of the Implementation/Assessment Activities.

### 5.2 Target groups

All the target groups that will be involved in OSOS's pilot phases will provide valuable direct and indirect data. By direct data we mean the answers using the tools like questionnaires, interview and / or focus groups. By indirect we mean the data that we be collected over the web from the OSOS web communities. The target groups that will be involved are:

- Head Masters and teachers from 1000 schools – More focused work is expected with the 100 Open Schooling Hubs.
- Students from 1000 schools
- External user groups and communities: families, science groups and local sociocultural associations, affiliated science centres and museums, research centres, CSOs, local authorities, industries
- Ministries of Education and local educational authorities

## 6 OSOS Impact Assessment Timeframe

This section illustrates the time plan of the impact assessment activities in the pilot schools. It has to be noted that the periods of intervention are quite long to allow the provision of significant data during the pilot work at all levels (school level, teachers' level, student level, community level). The project team has made a large effort to initiate the implementation work earlier (January 2018 instead of April 2018) to offer the opportunity to the evaluation team to acquire data from pilot schools for an extended period of time (3 years from the OSOS Open Schooling Hubs and 2 years from the additional 900 nodes of the schools' network). As described in Chapter 5, data will be collected from different target groups during the proposed intervention. These points take into consideration the availability of the schools/students/school heads during schooling calendar year as well as the need to support the consortium progress with the provision of data for project reporting. It has to be noted that a rich collection of data will be acquired from the OSOS platform (using the existing facilities and services of the Open Discovery Space portal) during the full life cycle of the project.

The Impact Assessment process for each school to be involved in the project is starting with the population of the Open School Development Plan (D2.2) and the completion of the Self-Reflection Tool (see Chapter 2). These documents could act as guides during the innovation process but they will need to be re-visited only after one year of full implementation work. The other instruments (presented on Table 3.2 and in D6.2) will be implemented according to the localised plans. For example, the SMQ and IMI questionnaires will be used following a pre-post methodology in specific time intervals (including also a meta-post-test in defined periods). At the same time data will be acquired from the system, e.g. number of community members in the school, number of external stakeholders in the communities, number of students projects. According to the OSOS work-plan two main periods of intervention are foreseen (see Table 6.1).

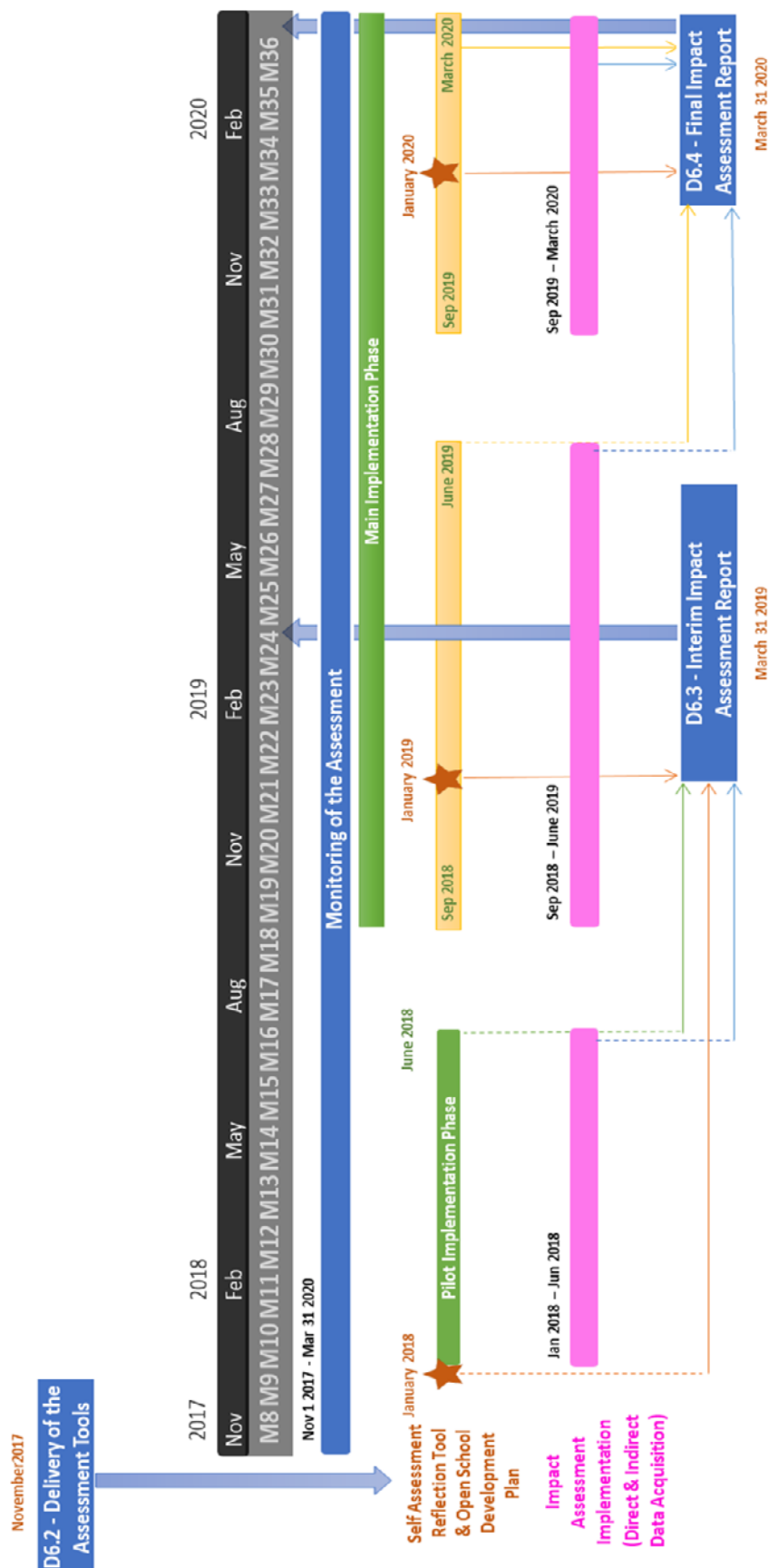
**Table 6.1:** *The overall impact assessment plan*

Target Group	Pilot Implementation Phase (January 2018 – June 2018)	Main Implementation Phase (September 2018 – June 2019) and (September 2019 – March 2020)
School heads and teachers	100 Open Schooling Hubs	1000 Schools
Students	100 Open Schooling Hubs	1000 Schools
External user groups and communities	100 Open Schooling Hubs	1000 Schools
Ministries of Education and local educational authorities	-	Educational authorities of the participating countries

In the framework of the first implementation period data will be acquired by the 100 pilot open schooling hubs. The aim of this **pilot phase** is to test the instruments and provide feedback to the impact assessment team to proceed in corrections or adaptations if necessary. The fact that the project is implemented at the same time in numerous countries could result to a series of adaptations and localisations of the tools. Based on the main findings of the first 6-month pilot phase the project team will proceed to the **main implementation phase** from September 2018 till the end of the project, in March 2020. During the second implementation phase all the impact assessment tools will be used to provide data for the population of the Open Schooling Competence Framework. Figure 6.1 depicts the overall impact assessment time plan while Figure 6.2 describes a hypothetical time plan for an individual open schooling hub that will be involved in the project from January 2018.

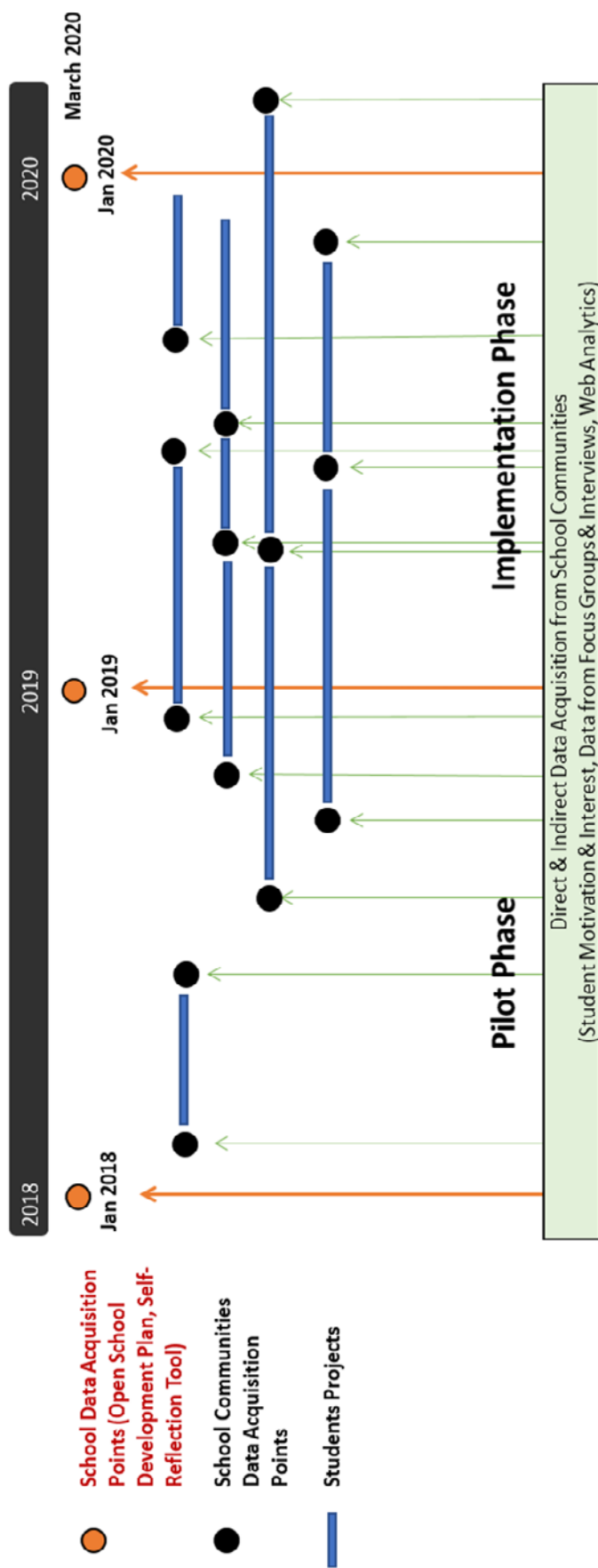






**Figure 6.1:** OSOS Impact Assessment - Data Collection Timeframe.





**Figure 6.2:** A hypothetical time plan for the project implementation in an OSOS pilot school. It depicts the data collection points during the transformation process. It includes three repeated cycles of school data acquisition and numerous interventions and studies during the realization of the project activities in the school setting.

## 7 Conclusions

This document describes the proposed Impact Assessment Methodology for OSOS project. The OSOS Assessment Methodology draws on interlinking methodologies on evaluation of school innovation on organisational changes, science pedagogy approaches, science-and-society research and students' problem-solving competence, interest and motivation which align with Responsible Research and Innovation principles. The OSOS Evaluation Framework presented offers a hybrid evaluation approach. The Impact Assessment Methodology will be based in two driving forces of the Open Schooling Model, on a) Rethinking How Schools Work and b) on developing an environment that facilitates the shift from Students as Consumers to Creators of educational activities.

Before schools can embark on change they need a clear vision and leadership. More specifically school leaders need to create a shared vision for how science education best can meet the needs of all learners and to develop a plan that translates the vision into action. This vision and planning processes should be based on holistic view of the current innovation status of the school. This transparent overview will allow for more targeted planning to address the specific issues that each school is facing, thus optimizing the efforts to overcome them. The vision begins with a discussion of how and why a community wants to transform learning. Once these goals are clear, science and research findings can be used to open new possibilities for accomplishing the vision that would otherwise be out of reach. A series of system changes can then occur: When carefully designed and thoughtfully applied, innovative projects can accelerate, amplify, and expand the impact of effective teaching practices. However, to be transformative, teachers need to have the knowledge and skills to take full advantage of the process and the outcomes of these project-based activities. In addition, the roles of teachers and teachers' trainers, parents, and learners all will need to shift as scientific inquiry enables new types of learning experiences. Furthermore, building teacher and leader capacity is vital to successful transformation. A successful change strategy requires professional development, feedback and support for teachers along with a well-researched monitoring and evaluation system. Organisational capacity, strategic planning and quality assurance are crucial parameters during the transformation journey. The abovementioned should be perceived from the schools during the OSOS pilots and these are the main aspects that are need to be monitored and assessed.

To measure these proposed transformations of the school unit the OSOS evaluation team will focus on the measurement of the Organisational Change and at the same time the measurement of the Pedagogical Impact of the proposed approaches and activities. To do so the project team has developed and extended list of 40 indicators to map the openness process in the participating schools. The main tools that will be used will be Questionnaires that will be used in different situations. The most important instrument is the Open Schooling Reflection tool. This will be the main tool to measure the organisational change and the RRI integration in the schools. The students of the participating schools will have also to fill in questionnaires according to the accelerators that they are going to realise. These will be mainly the questionnaires for the Motivation and the Interest of students after implementing activities according to the OSOS Implementation Plan.

Finally, there are going to be used the data from the web analytics, data that the OSOS Portal can provide in respect with number of communities created, number of resources and projects, number of users that participate in activities and communities etc.

At certain points during the Implementation phase there are going to be published Assessment Reports so to give feedback about the elaboration of the project's activities and needed actions that should be taken.

In the first implementation period the 40 indicators will be tested and possible modification will be integrated into the validation approach so to be implemented in the second phase of the implementation with the rest of the 900 schools that will participate in OSOS.



Deliverable 6.1 sets the framework for the development of the Evaluation Instruments that will be analytically described in D6.2.



## 8 References

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## 9 APPENDIX: PREVIOUS AND CURRENT INITIATIVES IN THE FIELD

### Inquiry in Science Classrooms: Science Education Now

This report was authored by a High-Level Group on Science Education tasked by the DG General, chaired by former French Prime Minister Michel Rocard (Rocard, 2007). This report further advances the concepts of inquiry-based learning and assessment approaches for young people as well as collaboration between formal and non-formal environments. “This” the report states “creates opportunities for involving firms, scientists, researchers, engineers, universities, local actors such as cities, associations, parents and other kinds of local resources (p17)”. The OSOS Open Schooling approach facilitates this interaction of community and regional stakeholders in the education of young people, aligned with the possibility of curriculum change to create a legacy for this learning and engagement. The report did not carry out a comprehensive evaluation, nor did the group explore the options in this regard. **It did, however, identify the lack of resources generally available for science education innovation going towards evaluation. There is an increased role, the Group concludes, for a process that “stimulates teachers to evaluate and reflect their teaching in a process of continuous quality development” (p15).** The concepts of “rethinking” and “renewal” are in evidence here; it is explicit that the old ways are not enough and culture change is required in the education system to facilitate open schooling. **This line of thought directly influences Organisational and Culture change category in OSOS.**

Inquiry-based Science Education (IBSE) is an open system of pedagogical tools that suits the OSOS system, and can be seen as the origins of how RRI and open schooling can occur in the OSOS ecosystems. While debating socioscience issues is a crucial element of understanding global RRI in the science classroom and how critical awareness and collaboration can be inculcated (Osborne et al, 2010), the OSOS model folds the ‘global openness’ concept onto the lab bench itself. Inquiry occurs from questions outside the school grounds but can be investigated in the lab or out in the ‘field’. Keys and Bryan (2001) brings the classic social constructivist and sociocultural education of Von Glaserfeld into the theoretical framework as rationale for young people’s engagement with IBSE. For teachers there is a new emphasis of the weaving into curriculum experiments and content the pressing issues of the everyday world. Quantitative and qualitative assessment of *teaching and community interaction* also falls under the rubric of Vygotsky social learning (Vygotsky, 1978), and communities of practice (Lave and Wenger, 1991), with particular emphasis on gender and language **These sociocultural, practice-based, and constructivist approaches to science education heavily influence the OSOS model.**

### From Inquiry to RRI: Ark of Inquiry

The Ark of Inquiry project centred around two, up to this point unrelated, concepts - connecting Inquiry-Based Science Education (IBSE) with Responsible Research and Innovation (RRI) (Bardone, 2016). Ark of Inquiry aims at raising youth awareness to RRI, as well as building a scientifically literate and responsible society through IBSE. The project developed a pedagogical framework for identifying inquiry-based activities that promote pupils’ awareness of RRI while collecting RRI-related inquiry-based activities and environments and making them widely available through the Ark of Inquiry Platform. The project builds on a large supportive community of trainee teachers, students, and researchers. **Ark of Inquiry used evaluation to develop instruments and collect data for evaluating the success and efficacy of the project to ensure that the pedagogical framework, the collected inquiry-based activities and the supporting community worked together to improve youth awareness towards RRI.** Inquiry-based activities were available from across Europe through the Ark of Inquiry platform and widely disseminated the approach in schools, Universities, science centres, and out to wider society.



Ark of Inquiry takes forward the constructivist approach of socioscientific issues and critical thinking for the student where the questions and solutions of science fits into the world around them. What Sadler (2004) called ‘social dilemmas’ can be addressed in the science classroom. These social dilemmas would include the societal challenges, but also controversial technologies such as GMOs, AI, nanotechnology and synthetic biology. There are social ethics questions at the heart of such reasoning, informal ideas brought into the formality of the school science setting. There is an element of embedding fundamental questions for the student as they conduct experiments or take data: why are we doing this in the first place? The reflective practice of ‘why science?’ becomes standard in the practices of science inquiry (Matthews, 2012) **This instils a critical thinking element to science pedagogy, where science and technology raises public doubts and concerns as well as positive attitudes.** The conceptual framework of Ark of Inquiry is therefore a direct descendent of OSOS. Socioscientific issues as well as attention to the conduct of the experiment become central to the process of inquiry for the learner. Science process is fundamental, considered before science product or content. **This is a formative study for science pedagogy in OSOS.**

### **The wider RRI research agenda**

**EnRRICH** is A 4-year H2020 project to network institutions that are introducing RRI into third level curricula using pilot projects of community- projects. A particular strength – with respect to OSOS intentions – is its focus on community networks as Communities of Practice (CoP) and how they may be incorporated into education. However, this is approach for third level only, and the emphasis is on ‘Science Shops’ as a means by which community projects are brought into curricula, thereby focusing on CSOs and social enterprises, but not industry. The evaluation WP, which has no disseminated deliverable as of Sept 2017, develops the ideas of student competencies and learning outcomes identified in WP2 with summative evaluation of how EnRRICH partners give feedback about the project, ensure accountability to stakeholders as well as maintaining the project’s overall internal efficiency (processes) and external efficacy (results).

**PERARES** set out to develop a set of indicators to evaluate influences of CSO and public participation in the development of scientific knowledge with reference to specific projects and actions; to make available guidelines and replicable instruments and practices for such evaluation; to be a resource for the project partners and individual work packages in their self-evaluation exercises. PERARES set a framework for evaluation of the economic role of science shops and to independently evaluate the progress made in achieving the objectives of PERARES regarding Public Engagement with Research and Research Engagement with Society. Self-evaluation became the main ethos of PERARES and the tools for data collection are still available for these. The goal of PERARES was to connect up all large science shops across Europe. It has been quite successful in influencing community-based and RRI policy in European Research Area.

**Indicators for promoting and monitoring Responsible Research and Innovation Report.** Early in 2014 the European Commission appointed an expert group ‘to identify and propose indicators and other effective means to monitor and assess the impacts of Responsible Research and Innovation (RRI) initiatives, and evaluate their performance in relation to general and specific RRI objectives’. This report presents the results of the work of the expert group. It contains three parts: first a conceptual introduction of RRI; second a detailed review of possible indicators in eight key areas for RRI policy; and third a number of concrete proposals for indicator design and implementation.

This report introduces two further features along with the six keys of RRI. The Sustainability and the Social Inclusion. Both are highly relevant to the OSOS approach especially in respect of the



Organisational Change that OSOS would like to introduce to schools (Rethinking How Schools Work). **Culture Change indicators arise directly from the work of this influential EC report.**

**NUCLEUS** is a 24-partner collaboration seeing to embed RRI in third level institutions through the concepts of 'nucleus' within a research /third level institution to which are connected several cells: policy, media, publics, CSOs and economy. One of the OSOS partners involved in evaluation is the evaluation lead on NUCLUES, Science View. Both focus on 'bottom-up, top-down' - governance and culture change. NUCLEUS utilise an approach for the integration of RRI into Research Institution following several already existing indicators (mainly from MoRRI, Indicators for promoting and monitoring Responsible Research and Innovation Report). The approach can be used in order to identify already existing indicators for NUCLEUS that could correspond to several aspects of OSOS. Also, there are similar approaches to be followed as NUCLEUS will implement activities in 10 Institutions coming from several cultural and economic backgrounds like in OSOS the schools that participate in the pilot phases. **Organisational and Culture Change indicators are influenced by NUCLEUS.**

**MoRRI Metrics and indicators of Responsible Research and Innovation** (2015 report) is perhaps the most influential of all evaluation projects in Europe in terms of impact of research and science funding policy. It uses a logic model of evaluation. MoRRI sets out a template for evaluation on the basis of actor descriptors and motivations, data collection ethics, the depth of suggested analysis for evaluation templates include sources of data, analytical 'levels' (whether logic model or aggregation) and linkages to other RRI dimensions. **This will be highly influential for implementation of the OSOS Assessment Method in respect to the proposed templates to describe the metrics for each indicator, as well as budgets and resources required.**

**Engage 2020** is possibly the most cited of H2020 projects for science communication and public engagement (and broader RRI) given the exhaustive number of models and activities of engagement it presents as typologies. While formal education may have limited use for these models and activities, these will be crucial for informal methods and will be an excellent resource when considering activities across Europe. Evaluation data gathering (for WP6 but also self-evaluation techniques) can utilise these methods.

### **Global responsible citizenship in the wider classroom: UNESCO: Re-thinking Education: Towards a global common good?**

An important RRI focus are the UN Millennium goals on global societal challenges and societal challenge-based research and these form the background and central thinking behind RRI in education (UNESCO, 2015). This is a broad vision of education, in which science education is part of a complex ecosystem of well-being and inquiry for young people. There is a focus on the challenges of eco-sustainability, the need for a humanistic approach to education (which has not been an obvious approach in science education, despite the obvious linking mechanisms (Wu, 2012), the context of global policy-making and the reframing of education as a common good. The report also considers the risk and challenges of greater science and technology, but seed the potential for AI, ICT and neurosciences as new frontiers for science, culture, and global development. UNESCO recognises the complexities and uncertainties of the future, and the adaptability and resilience of young people is a paramount. The report draws attention to the blurring of the boundaries of public /private in terms of funding models and ownership – they warn against the dangers of turning a 'public good' into a 'private consumable product'. The allegiances and assemblies created by RRI – networks of industries, CSOs, education and research sectors, as well as 'general publics' are included. Again there is an emphasis on a 're-think'. The National Coordinating Centre for Public Engagement(NCCPE) in the UK and many others explored the engagement agenda to see how education would respond to these societal challenges (Kelly and McNichol, 2011). The OSOS valuation applies their Socially Modified Economic Valuation approach for higher education to the primary and secondary systems, focusing on 'outputs' for societal collaboration rather than the direct 'worth' of education. At this point in the review, we

see a progression from inquiry that is student-scientist focused to inquiry that is global challenge-focused. These reports contribute to the Valuation assessment of the OSOS Model, a value system beyond traditional economics, and the broader landscape for how we might consider indicators for Organisational and Culture Change.

### **RRI in science classrooms: EC Guidelines from Science Education for Responsible Citizenship Report**

This is a well-cited report, with rapporteur Ellen Hazelkorn, and a key text in this review with respect to linking RRI with science education (European Commission, 2015). Many studies have now taken an interdisciplinary focus for science. The Institute for Development Studies (2006) sees science as a principal way of addressing world poverty, through a 'glocal' approach – can an experiment or a scientific argument in one region address and help solve a serious challenge on the other side of the world, while enriching the local area itself with regards to education? In *Science Education for Responsible Citizenship* interdisciplinary 'STEAM' education is emphasised as an approach to *responsible citizenship* in the classroom, but with a focus too on jobs and innovation. According to the conclusions: "[STEAM would] ease the transition from 'education to employability' (E2E), by ...learning about science through other disciplines and learning about other disciplines through science; strengthening connections and synergies between science, creativity, entrepreneurship and innovation (ibid p 9)." In the context of future scientific careers, the OECD (2012) has identified creativity as high as scientific and technical competence for future skills in global populations.

There is also an emphasis on connecting industry and innovations to community as a way of optimizing not just science education, but its RRI dimensions: "Links between Responsible Research and Innovation strategies at local, regional and national level should be strengthened and evaluated in order to overcome regional and other disparities across Europe and to increase the innovation capabilities of enterprise, particularly SMEs." Online collaboration was seen as necessary for such an open approach (see also Linn et al 2014). From this report, the assessment framework can integrate approaches on how to evaluate and monitor the development of students' competencies. Key to the OSOS project is a reconceptualising of RRI for education and the Science Education for Responsible Citizenship report has set out the way forward. **This report defines indicators for organisational, Science Pedagogy and curriculum change and entrepreneurial/ economic Valuation issues.**

### **Organisational Cultures and Culture Change: Principles and Big Ideas of Science Education and Open Discovery Space (ODS)**

The Open Discovery Space (ODS) addresses the various challenges that face how schools adopt e-learning in the European context. The interface has been designed for students, teachers, parents and policy makers. The expert –driven report that accompanies the project edited by Wynne Harlen (2010) examines how students can be facilitated to consider and learn about science more than science literacy, this appears to aim towards engaging those not directly connected with science, or who never will be scientists – engagement and policy become the RRI dimension. The paper is a foundation for Open Schooling as a concept. The three dimensions of science education identified were: 1) understanding of a set of 'big ideas' in science which include ideas of and about science and its role in society, 2) scientific capabilities concerned with gathering data and using evidence and 3) scientific attitudes. Beyond inquiry, constructivist approaches and assessment techniques that relays contributor data back to the educators were emphasised. Bell and Cowie (2001) have defined formative assessment in this context as "the process used by teachers and students to recognize and respond to student learning in order to enhance that learning, during the learning" (p536).

One weakness in terms of its usefulness to OSOS is that there was no evaluation as part of the project design but Harlen's consideration for evaluation was to have educators evaluate - and allow students



to do so also – those arguments that have no evidence or basis in science. Nevertheless, **this report guides the OSOS approach to Organisational and Culture Change but also identifying intercultural barriers.**

### **New Models for School – Research Centres Cooperation: the CREATIONS project**

Continuing the ‘STEAM’ concept, the CREATIONS project fosters creativity in science and technology, carried out by a network of science centres and science museums as well as academic institutions. It is based on the developed the 4Ps method to which OSOS also has some conceptual grounding:

- **pluralities:** opportunities for students and teachers to experiment with many different places, activities, personal identities, and people
- **possibilities:** opportunities for possibility thinking, transitioning from what is to what might be, in open possibility spaces
- **participation:** opportunities for students and teachers to take action, make themselves visible on their own terms, and act as agents of change
- **playfulness:** opportunities for students and teachers to learn, create and self-create in emotionally rich, learning environments.

There is a performative turn here, as Chappell et al (2012) and others move the conversation into performing arts and embodiment for science education. For CREATIONS, the point at which the creative meets the science is the area identified by the ‘4Ps’. The assessment methodology of CREATIONS is focused on the motivation and the interest of students in science, technology, engineering and maths (STEM). CREATIONS follow specific methodologies to assess the raise of interest of student to follow science careers. **This assessment methodology is the basis for the OSOS assessment methodology in respect to the Shift from Students as Consumers to Creators. The entrepreneurial spirit of innovation and consideration for local economy and Valuation will also be guided by this project.**

### **Self –assessment in the digital age: the SELFIE tool**

SELFIE is a self-assessment tool for the evaluation of use of technology and the digital literacy of a school. The concept comes from the Digitally-Competent Educational Organisations (DigCompOrg) conceptual framework (Kampylis et al 2015). The system works on tasking schools to reflect on digital take-up annually. In terms of evaluation, it is limited to digital literacy, but also a non-hierarchical ‘progress’ system that does not measure quality. The European Commission’s Opening Up Education initiative underscores the importance of developing online skills for students *and* teachers. DigCompOrg technologies are designed to be used for encourage self-reflection and self-assessment within educational organisations as they progressively deepen their engagement with digital learning and pedagogies. The appraisal element is actually designed for policymakers, reflecting on governance and top-down strategies as well as bottom-up initiatives. The DigCompOrg is intended for primary, secondary, and further education schools as well as higher education institutions such as Universities to self-reflect on their progress in integrating and effectively using digital learning technologies. Pedagogical, technological, and organisational changes are expected as impact. In the assessment of this current project, OSOS can utilise this scoring mechanism for the online platforms. **SELFIE is therefore a guiding influence for data collection around technology adoption and use.**

### **Self-reflection tool for assessing the integration of RRI principles in schools: RRI Tools**

RRI Tools is a Horizon 2020 collaboration between 20+ European actors that include policymakers, academia, industry and science museums. It has swiftly become the go-to project for activities around RRI, including science education. The RRI keys – open access, gender, public engagement, ethics, science education and governance, have been interpreted and operationalised into practical models



and activities for the research, education and business communities as well as policy makers, and the ‘third sector’ (CSOs). Much of the RRI stems from converging areas of science communication (Wynne 1992) and science studies (Ravetz, 1987, Stirling, 2010). The concept goes further, future-proofing for possible shifts in policy agenda and nomenclature that may move away from ‘RRI’ in the future and towards ‘open science’ Stilgoe et al’s (2013) new conceptualisation of RRI arising from the ‘4 process dimensions’ of the Rome Declaration is also part of its schema : anticipation, reflexivity, inclusivity and transparency For science education, RRI Tools refers back to the UNESCO report on ‘Rethinking Education’. The evaluation suggested that teachers include a means to assess collaboration, reflection and content skills [in ‘RRI in practice for schools – Handbook for teachers’]. Entrepreneurial support and critical thinking are also part of the fostering process. **The Self-Assessment Toolkit of the RRI Tools is the basis for the assessment of the RRI Integration in OSOS Schools and measuring organisational change and any attending sociolinguistic barriers.**

### **Assessing the Science Capital of Communities: ASPIRES Enterprising Science and the Lamy Report**

Three organisations coordinated the ASPIRES Enterprising Science Project University College London, British Petroleum and the Science Museum London. This final report explores the relatively new concept within Public Engagement with Science and Technology of ‘science capital’. Although it has hints of the ‘deficit model’, the concept (borrowed from the ‘social capital’ proposition from French theorist Pierre Bourdieu (Archer et al, 2017)) identifies that lack of engagement with science with young people is more culturally and sociologically embedded – it is more than science literacy but also disposition/preferences and symbolic value of the concept of science, through ease or difficulty of access through peers, families, schools , socioeconomic structures to science. Nomikou et al (2017) and others have popularised the idea from King’s College, London. With science capital, we see a continued theme of critical thinking: the *habitus* of Bourdieu means the student has a passive-active relationship with her surroundings – she can both change and be changed by her actions, whatever career she chooses. For STEM careers., it is possible to embed the skills of critiquing the status quo, to be active citizens as well as objective researchers. The ASPIRES evaluation depended on: teacher reflections on their Continual Professional Development; amount of social and peer-to-peer learning among students present; outcomes tied to actual everyday curriculum /pedagogical change data collection was qualitative, following the qualitative approaches of Yin; in-depth interviews with teachers and digital fieldnotes; schools selected based on ethnic backgrounds of students, such as socioeconomic status, gender, faith –based. Museum themes were used as the conceptual driver. This could be perceived as a weakness as the same barriers to access to science (capital) can easily be transferred to the elitism of museum spaces.