R4C

Reflecting for Change

Deliverable 4.1

Validation Methodology and Plan

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Document Control Page

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Title	D4.1 Validation Methodology and Plan
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Abstract	This document describes the R4C Validation Methodology. This deliverable is building on the concept of e-Maturity and School Openness and extend it to incorporate the competences and/or professional identity of the teaching staff regarding a) to the use of ICT and b) the adoption of an open culture in their practice. A state-of-the-art systematic literature review and analysis of existing e-Maturity and School Openness frameworks is presented so as to formulate a detailed set of School Innovation elements.
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Document Control Page

Version	Date	Modified by	Comments
01	30/3/2020	SV	1st draft of the ToC delivered by SV (Structure)
02	6/4/2020	EA	Recommendations from EA about the structure
03	13/4/2020	SV	2nd draft the ToC delivered by SV (Final Structure)
04	20/4/2020	SV	3rd draft (final) including all the parts of the deliverable, delivered by SV
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Executive summary

This document describes the R4C Validation Methodology. This deliverable is building on the concept of **e-Maturity** and **School Openness** and extend it to incorporate the **competences and/or professional identity of the teaching staff** regarding a) to the use of ICT and b) the adoption of an open culture in their practice. A state-of-the-art systematic literature review and analysis of existing e-Maturity and School Openness frameworks is presented so as to formulate a detailed set of School Innovation elements.

The purpose is to propose and present **a strategy to evaluate the effects of, and systematically validate the proposed Innovation Model (WP1).** Using as a reference the schools performance in a 12-month cycle of pre- and post-evaluation of their e-maturity and openness (by using the SELFIE and the OSOS-SRT tools), the validation of the project impact is focusing on the effects (wished and unwished) and barriers to adoption in relation to the following aspects in the participating schools: impact on the processes of learning, teaching, and assessment; impact on the students outcomes; impact on the classroom as a whole and the school as organization; overall acceptance of the innovation; and corresponding organizational and ethical issues arising. An experimental design involving quantitative and qualitative research will be applied, whereby data will be gathered, analyzed, findings synthesized, and evaluation reports produced at key points to serve the needs of the project.

The validation plan is consolidating the work realized in the different areas of the project; the Self-Reflection Process, the School Innovation Model, the school community involvement, the large-scale pilots, teachers and students' competencies. The Validation of the School Innovation Model will involve 300 schools from Greece, Italy and Portugal.

In Chapter 1 the main axes of the R4C Validation Framework are presented. The Validation Methodology will be based in two driving forces: a) **progress of the school towards openness** and b) **embedded digital technologies**.

Chapter 2 is the main chapter of this document and presents the description of the framework and how the validation approach is going to take place. The framework is building on the concept of **e-Maturity** and **School Openness** and extend it to incorporate the **competences and/or professional identity of the teaching staff** regarding a) to the use of ICT and b) the adoption of an open culture in their practice. A state-of-the-art systematic literature review and analysis of existing e-Maturity and School Openness frameworks will be performed so as to formulate a detailed set of School Innovation elements.

In Chapter 3 the main aspects and objects that will be assessed during the project's lifetime, are described. The project team will use a set of indicators that will be based on the list of the 40 indicators that were used in OSOS project and will be monitored during the process through different instruments and techniques. Also, this chapter is introducing the validation tools that will be used and will be presented in detail in Deliverable 4.2.

Chapter 4 includes a short description of the target groups and the involved stakeholders. It describes how the National Coordinators are going to support the validation procedures in the local settings in the framework of the project's implementation phase. The target communities will provide feedback from the R4C activities within the schools in this user-centred approach.

Chapter 5 presents the timeframe of the R4C Validation 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 localized by the National Coordinators to the different pilot sites.

Chapter 6 presents conclusions of the current work and describes the future action in the framework of WP4 during the whole project cycle.

Table of contents

1 Introduction

1.1 Purpose of the document

The purpose of the assessment and validation plan is to outline the methodology that will be followed for all relevant activities that will be carried out throughout the project. This work mainly aims to map the impact on students' 21st century skills and to validate the impact of the implemented strategies and their use on pilot classrooms. Assessment activities are foreseen to be run during the whole lifespan (whole school year) of the large-scale pilots. The proposed methodology will study the expected impacts from multiple perspectives, allowing comparisons between classes that follow different teaching approaches and thus contributing in the deeper understanding of the field.

R4C will explore how schools may **move from self-reflection to developing a comprehensive plan of action that utilises the results of a pre-post self-reflection process**, but, crucially, in combination with fundamental principles and mechanisms of European educational policy for schools. The latter is rather significant in the sense that improvement in key areas within an evaluation scheme for schools is not an isolated process but has to be aligned with key priorities at both the national level but also at European level. The project is relying on two established self-evaluation methodologies:

- **SELFIE (Self-reflection on Effective Learning by Fostering the use of Innovative Educational Technologies** - https://ec.europa.eu/education/schools-go-digital/about-selfie_en) which is a tool designed to help schools **embed digital technologies** into teaching, learning and student assessment. It can highlight what's working well, where improvement is needed and what the priorities should be. The tool is currently available in the 24 official languages of the European Union.

- The **Open Schools for Open Societies Self-Reflection Tool (OSOS-SRT)** (https://portal.opendiscoveryspace.eu/osos/srt) which is a tool that monitors the **progress of the school towards openness** at three different levels, the Management Level, the Process Level and the Teachers' Professional Development Level. It is available in 10 official languages of the European Union.

The school performance between the two measurements will be the reference point for the overall intervention of the project.

The assessment and evaluation team will look at how schools can be supported in using these tools to understand the current position of the organisation and build on the results to define and implement suitable action plans **by providing a step by step support mechanism for school heads and teachers.** The activities during the assessment and evaluation procedures will offer to R4C the opportunity to study the actual processes and unique pathways (rather than looking simply into variations in scores) from self-reflection results to concrete actions in the school as a learning ecosystem, in key areas such as **Teacher CPD**, **school management**, **school openness**, **technology integration**, **innovation uptake**, **community engagement**, **social responsibility** and others.

The 1st results from the measurements (pre) from the Self Reflection process, along with the School Innovation Profiling Tool, School Innovation Planning Recommendation System and the Analytics Representation and Vizualization will help school heads to develop their strategy.

1.2 Scope and audience of the document

This document aims to provide the consortium partners, and mainly the National Coordinators, with an overview of the R4C Validation Methodology and a plan of actions that will be needed. The R4C Validation Methodology will be also available to the school heads from the participating schools. 300 schools from Greece, Italy and Portugal will participate for one school year in the activities of the project and will utilise the methodology as well as will use the proposed Validation Tools (D4.2).

2 Validation Methodology in R4C

2.1 R4C Validation Framework

The development of the R4C Validation Framework was informed through an extended review of relevant project reports and documents referring to pedagogical principles, school innovation aspects, RRI integration in school settings, organizational 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 education projects that also integrate RRI principles. The EC Reports and the projects reviewed are presented in detail in Appendix (Chapter 8).

Figure 1 describes the overall Validation Framework that is proposed by the project team. The Impact Assessment Methodology will be based on two driving forces of the Innovation Model (see D1.1):

- Progress of the School Towards Openness
- Embedded digital Technologies

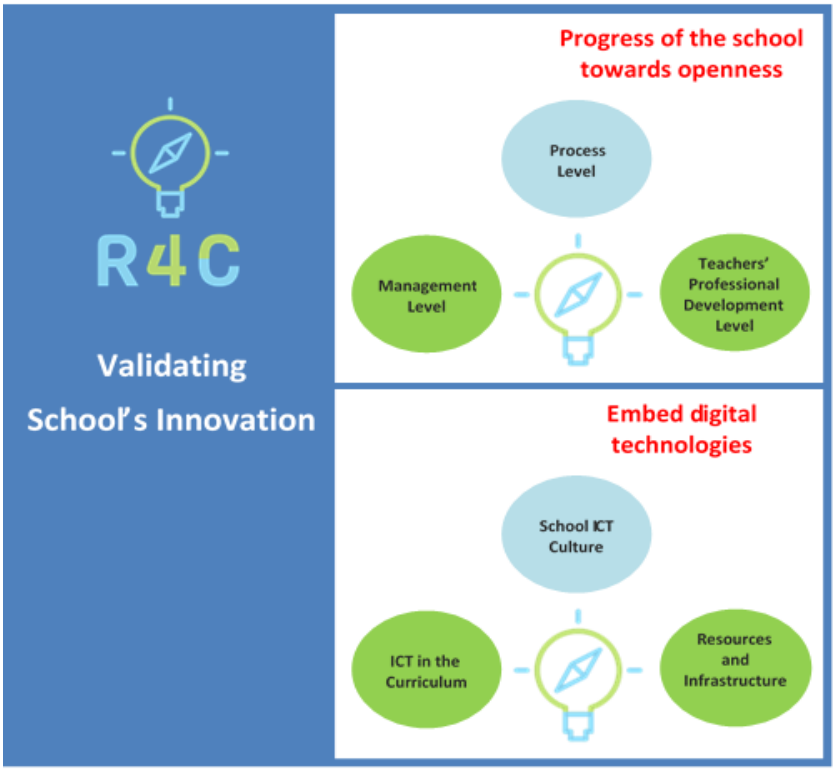

Figure 1: The overall validation framework for monitoring the R4C Schools' Development during the implementation phase

The framework is building on the concept of **e-Maturity** and **School Openness** and extend it to incorporate the **competences and/or professional identity of the teaching staff** regarding a) to the use of ICT and b) the adoption of an open culture in their practice. A state-of-the-art systematic literature review and analysis of existing e-Maturity and School Openness frameworks will be performed so as to formulate a detailed set of School Innovation elements.

The **strategy that will be followed will be to evaluate the effects of, and systematically validate the proposed Innovation Model.** Using as a reference the schools performance in a 12-month cycle of pre- and post-evaluation of their e-maturity and openness (by using the SELFIE and the OSOS-SRT tools), the validation of the project impact will focus on the effects (wished and unwished) and barriers to adoption in relation to the following aspects in the participating schools:

- impact on the processes of learning, teaching, and assessment;
- impact on the students' outcomes;
- impact on the classroom as a whole and the school as organization;
- overall acceptance of the innovation;
- corresponding organizational and ethical issues arising.

An experimental design involving quantitative and qualitative research will be applied, whereby data will be gathered, analyzed, findings synthesized, and evaluation reports produced at key points to serve the needs of the project.

This work mainly aims to map the impact on students' 21st century skills and to validate the impact of the implemented strategies and their use on pilot classrooms. Assessment activities will run during the whole lifespan (whole school year) of the large-scale pilots. The proposed methodology will study the expected impacts from multiple perspectives, allowing comparisons between classes that follow different teaching approaches and thus contributing in the deeper understanding of the field.

Designing a framework for the assessment of such implementation activities is not a simple task in current school environments. So, R4C 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. In the following paragraphs we are describing the different axes of the proposed framework in detail.

2.2 Progress of the School Towards Openness

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. This is the heart of the R4C proposed Innovation Model. The School should operate as a learning organisation and improve according to the specific R4C criteria.

The scope of the Validation Methodology is to monitor the proposed Innovation Model's processes (strategies) and to provide the results on how this model is performing in order that specific strategies and tools are proposed to the school management. Following the proposed strategies, we are expecting to increase the performance of the school at different levels. Within the scope of the R4C 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, 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 specific criteria. For this reason, the R4C Validation Team will build on the OSOS Self-Reflection Tool. The tool is based on the three levels that were presented. For each one of the above-mentioned levels the tool is reflecting upon 8 aspects (items).

Table 1. The Three Levels of change of OSOS SRT

	Management Level	Process Level	Teacher's Professional Development Level
1	Vision and Strategy	School Leaders and Teachers Shaping Learning Systems	Teacher Awareness and Participation
2	Coherence of Policies	Creating an inclusive environment	Setting Expectations
3	Shared Vision and Understanding	Collaborative environments and tools (co-creation, sharing)	Professional Culture
4	Education as a Learning System	Implementing Projects	Professional Competences, Capacity Building and Autonomy
5	Responsible Research, Reflective Practice and Inquiry	Parents and external stakeholders' involvement in school's activities/projects	Leadership Competence
6	Motivation Mechanisms	Reflect, Monitor, Debate	Collaborative learning (mobility actions)
7	Plans for Staff Competences	Learning Processes adaptation	Collaborative learning (ICT Competences)
8	Communication and Feedback Mechanism	Established collaboration with local, national institutions	Use and reuse of resources

If look closer to the items of the above table we could realise that this tool is reflection also to RRI aspects as well as in ICT introduction into the school environment.

For each one of the 8 aspects in each level the school has to choose one statement that correspond to the actual situation at the time. Each statement corresponds to a school typology, according to the school's readiness to adapt an open schooling culture.

According to the response in each one of the aspects the school will be characterized as:

Table 2. Statements that Correspond to a school typology

ENABLED	CONSISTENT	INTEGRATED	ADVANCED
Schools that are at an initial stage of incorporating educational innovation in the classroom and beyond	Schools that have achieved a certain level of innovation and openness through specific measures, educational ICT tools, best practices, CPD, but they still consist isolated cases without a network of other schools and	Schools that have achieved a high degree of innovation and openness and they have already established cooperation with community stakeholders and other external partners	Schools that are considered rather extreme cases of schools that offer a glimpse to the open school of the future

	external partners to facilitate the process		

After the completion of each one of the required sections of the self-reflection tool, the School Head (the school) will get a report that will include the answers in each one of the sections as well as the results of the reflection. The report will present their answers as a table for each one of the sections as well as will inform about the status in relation to its openness. There will be four categories where a school will be categorised:

- Enabled (0-25%)
- Consistent (25-50%)
- Integrated (50-75%)
- Advanced (75-100%)

Along with the results, concerning the category in which belong, the school heads and/or the individual teachers will be informed in practical terms for:

a. the tailored R4C Strategies to support the local schools as they transform themselves into innovation schooling environments
b. the package of the supporting services that they could use (specific activities)

2.2.2 RRI Integration

The R4C Validation Methodology is focusing on assessing, at the same time, 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 all, 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 popularized 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 Innovative 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 Innovative 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 Innovative 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

Innovative 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 R4C will provide the means and the tools along with the necessary collaborative and personalization functionalities to introduce learners in extended episodes of deep 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?

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 R4C we will follow an assessment that will identify the level of each school's competence. Hence, R4C will try to move beyond the existing RRI evaluation processes and will introduce the RRI integration indicators to the R4C Innovation Model.

2.3 Embed Digital Technologies

The data that will form the overall score of each school will be collected through several tools that will be presented in the D4.2. In D4.2 the specific contribution of each one of the indicators will be presented so to provide the information on how the R4C Validation Methodology will measure the effectiveness of the proposed process and the Innovation Model for every school. R4C Validation project team will develop the self-assessment tool to help schools' progress innovation and growth. In the previews paragraph we explain the 1st driving force (Openness). For the 2nd driving force the Validation Team will be based on the SELFIE Tool, from which the main aspects will be integrated with the first's driving force elements that were presented. **SELFIE (Self-reflection on Effective Learning by Fostering the use of Innovative Educational Technologies** - https://ec.europa.eu/education/schools-go-digital/about-selfie_en) which is a tool designed to help schools **embed digital technologies** into teaching, learning and student assessment. It can highlight what's working well, where improvement is needed and what the priorities should be. The tool is currently available in the 24 official languages of the European Union. 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). This approach has been adopted 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. 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 3 presents the results from 1200 schools that participated in the Open Discovery Space pilots in 2015.

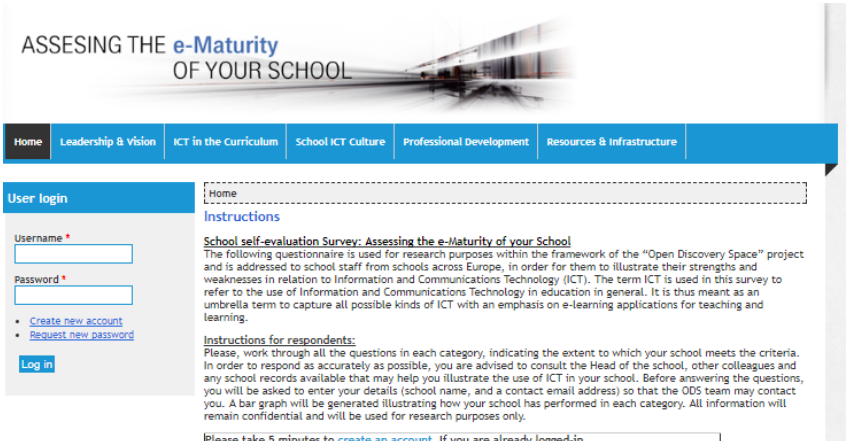

Figure 2: The entrance point to the Open Discovery Space

e-maturity tool for schools. The focus areas are Leadership & Vision, ICT in the Curriculum, School ICT Culture, Professional Development and Resources - Infrastructure.

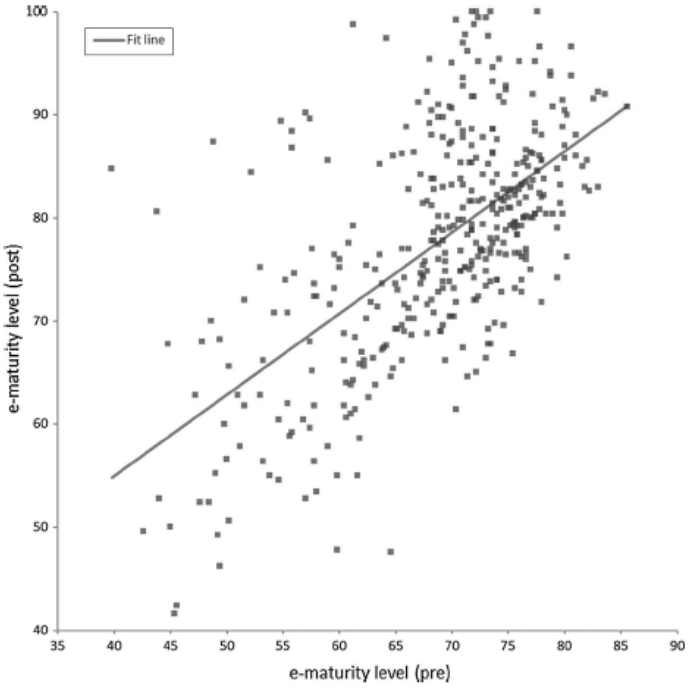

Figure 3: **The e-maturity self-reflection tool assessing change/impact was completed by N = 1200 schools in 2015. An increase in the e-maturity scores of 955 schools was recorded, while in 45 lowered scores were observed. Results from all e-maturity questionnaires show an increase of 8.61 % in the digital 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.**

2.4 Contribution of the R4C Validation Framework

The R4C Validation project team will integrate all the approaches presented in the previous paragraphs into the respective tools for implementing the validation methodology. These principles will be the input in order to develop the Validation Tools which will be analytically described in D4.2. The R4C Validation Framework will introduce relevant key indicators for the school innovation which are presented in Chapter 3 and will be finalised in D4.2 along with the development of the Validation Tools. The focus of the proposed framework will be to support schools to introduce an innovation culture in their settings and measure the impact. Evaluation of impact of schooling activities will consist of the following activities and analyses:

- Short term - assess activities and immediate enjoyment/impact using surveys to all participating stakeholders for each activity - collaborate on ongoing basis with little variable change
- Medium-term - focus groups, phone interviews - was engagement heightened, identify challenges, track social media, analyse portal use, pre and post engagement survey analysis.
- Long-term: Take up of school innovation model - national statistics, including gender statistics, number of institutions engaged in process - legacy. Changes in culture/framing in media- interest from new partners to engage.

Through the use of the innovation 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 innovation 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 innovation 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 customizable to the needs of the participating schools.

3 Monitoring the Emergent Innovation in Schools – Introducing Assessment Indicators and Tools

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

As has been mentioned in the previous sections of this deliverable, the R4C 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 school typology (presented in Table 2), schools can identify their level of readiness (phase) to adapt to an innovation schooling culture. For each school (and phase of its readiness) the R4C 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 R4C support in guiding school dynamics toward an innovation schooling culture is essential in lowering the barriers to innovation. R4C 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 R4C Innovation Model and 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 R4C 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 organizational settings in general. It is very crucial for the success of this intervention the R4C team to provide schools with the necessary reflections to their efforts to innovate. In this chapter we describe the overall framework that the R4C project aims to implement in this reflection process and we are introducing an extended list of indicators that will be used to define the final R4C indicators and respective validation tools which will be analytically described in D4.2.

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 R4C 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 organizations (Arena *et al*, 2017), the authors emphasize (a) the power of network structures and (b) the ability of organizations 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 organizational 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 organizational context that allows people, ideas, information, and resources to flow across the organization 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/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 organization).

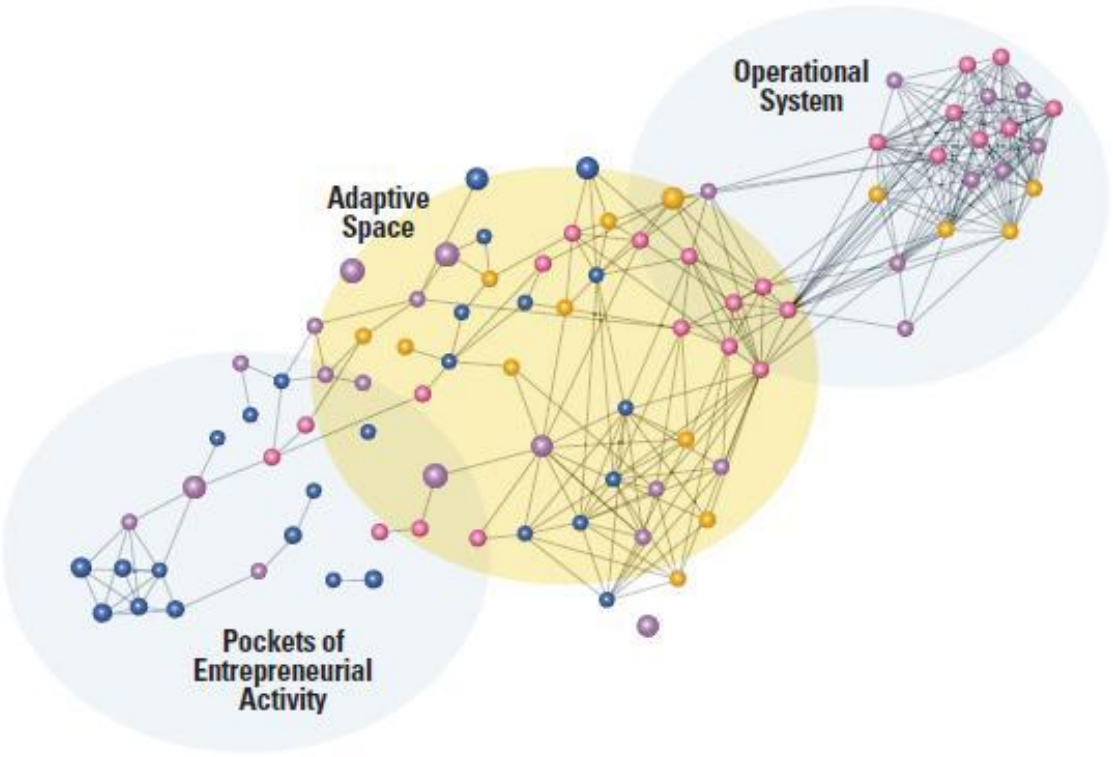

Figure 4: Depiction of the adaptive space "area", which opens up information flows, enrich idea discovery, and carries the innovative/entrepreneurial activity from "pockets" to the "center" (that is, the operational, "formal" system) of the organization (Source: Arena et al, 2017).

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 organization (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 organizations, Arena et al (2017) found that innovation leaders within an organization 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 "energizers", and how individuals can drive emergent innovation in adaptive space. The three network roles are depicted in Figure 5.

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 energizers) have been identified in order to position innovators and to catalyze emergent innovation within an organization.

Brokers: "Brokers build bridges from one group to another within and outside an organization. As a result, they act as critical conduits of information and ideas. Specifically, brokers offer three competitive advantages to an organization: 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 organization. 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 organizations, 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 organization (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 jeopardize 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."

Energizers: "Energizers help push people beyond the safe bets. In an organizational network, energizers may be brokers, central connectors, or simply other individuals who enthusiastically adopt an idea and promote it. Energizers 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 organization. It challenges people to think more boldly than they would within their own subgroups and creates a contagious mindset as the innovation progresses." Energizers are able to fully engage in interactions, inspiring others to devote more time and energy to an initiative. The reputation of an energizer spreads quickly across the network, attracting others to aggregate multiple ideas into bolder, integrated concepts that are more likely to succeed. Energizers 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 energizers, the roles of which are described in Table 3 (from Arena et al, 2017).

Table 3: What Brokers, Central Connectors, and Energizers Do

Brokers, central connectors, and energizers play important roles in successful innovation processes within large organizations. While brokers and central connectors represent distinct positions in a network, energizers can be anywhere in a network; they can be brokers, central connectors, or other individuals.		
Brokers	**Central Connectors**	**Energizers**
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	Organize 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

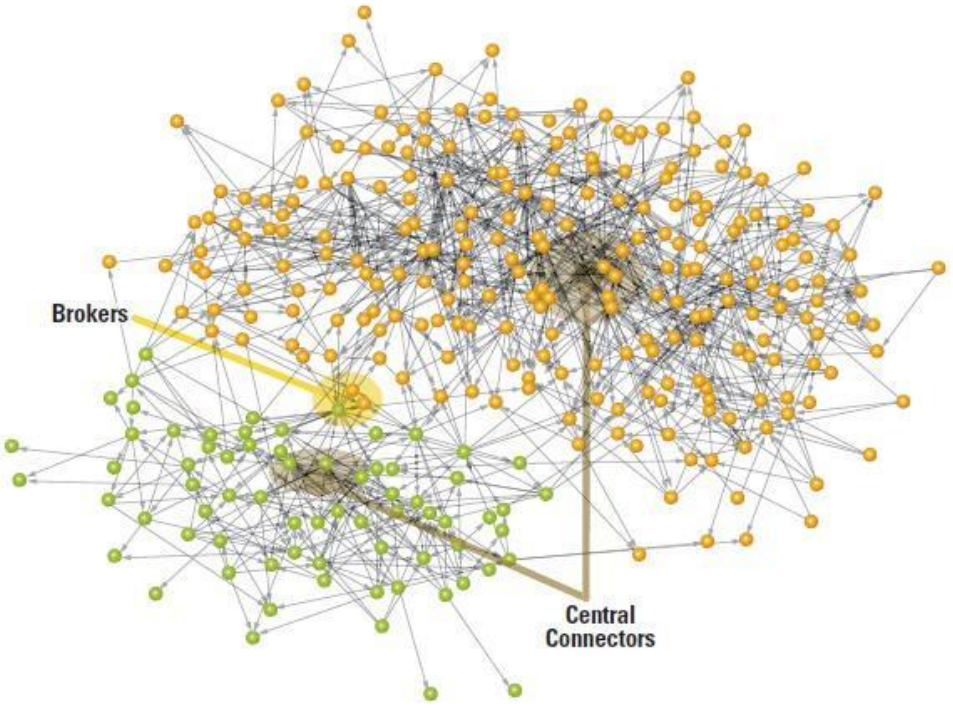

Figure 5: The diagram represents information flows in a portion of the network within a unit of an organization. The orange and green colors reflect two different sub-units of the organization that should have been working more closely together — but the network diagram reveals that large-scale collaboration 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 organizations, 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 organizational networks to allow innovation to

emerge and be incorporated into the organization'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

At this stage the R4C Validation Team will be based on a list of indicators that were developed during the OSOS project and assessed them with 500 schools. This list includes an extended list of indicators (40) in order to map the transformation process of the schools in the different phases of the openness and innovation growth. The final list of the indicators will be presented along with the Validation Tools in D4.2. This is necessary as 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 innovation 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 the R4C approach innovators need to be mutually responsive within and beyond their communities so the project team will explore the potential of the participating schools to share their practices through the development of a school network that could have local, national or international character. The localized assessment approaches will estimate the impact on both individuals and schools as an organization, as well as on the development of effective cooperation with organizations like universities and research centres, informal learning centres (e.g. museums and science centres), enterprises, industries and the local communities.

The proposed indicators will offer an integrated approach for the R4C impact assessment. The existing indicators will be updated and/or enhanced in order to describe numerous characteristics of the innovative schooling environment R4C 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 innovation performance.

Table 4: The list of indicators that were developed during the OSOS project and will be used as a basis for the R4C list of indicators to Monitoring the Emergent Innovation in Schools.

Indicators
1. **The school has a clear vision and strategy** towards open schooling
2. At least one **appointed teacher with clearly defined actions** to support the open schooling strategy
3. **Strategies** to encourage Problem Solving, Team Work, Active Citizenship, Critical Thinking and Gender Equality exist
4. **Approaches aimed at replacing competitive type classroom** environment with more collaborative working approaches (that also addresses gender equality and inclusion) exist
5. **Plans for professional development of teachers** for School Staff to foster a change in behaviour, enabling teachers to adapt to the open schooling culture
6. Strategies for teachers to participate in **international mobility actions** are in place
7. A **motivation mechanism is set-up for teachers/students undertaking innovative projects and social entrepreneurial behaviour. Brokers, central connectors, and energizers are getting in action.**
8. The school supports the development of an interdisciplinary environment where **students/teachers are encouraged try new ideas and approaches exists**
9. **Parental engagement is integrated** into the school planning structure
10. School supports and introduces **student-led social enterprise start-ups community-focused courses**

11. School has an ongoing system of teacher and student self-reflection, discussion and learning set-up
12. Teachers/students **engage in platforms for sharing best practice and lessons learned**
13. Schools set up a **system to reflect, track and monitor** how open school practices have shaped the school organisational culture
14. **Parents actively collaborate** with the OSOS projects organised by the school
15. There is a **commitment to changing the school at all levels**
16. Students and teachers incorporate a process of ongoing learning and evaluation into lessons and projects
17. Students and teachers receive **feedback from community partners** and **adapt** projects, where possible, based on this feedback
18. Schools encourage and engage in **reflection, discussion and debates** on scientific and societal issues
19. **All actors mutually benefit from the engagement** 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
20. There is evidence of an **economic benefit-associated engagement** of all partners
21. School has a **system in place which captures the profiles, needs, contributions and relationships of all relevant external stakeholders**
22. Students identify and align stakeholder needs with **matters of local social and economic concern**
23. School actively **promotes the collaboration** with non-formal and informal education providers, enterprises and civil society organisations
24. School **engages in a number of projects which demonstrate stakeholder inclusion**
25. School engages with outreach groups of research organisations to gain further **insight into the life and careers of scientists/engineers** (paying special attention into providing role models for all genders)
26. There is evidence of **parental engagement in school projects**
27. Schools **increase the science capital of their communities**
28. Local/regional/national businesses and organisations **share their infrastructures and collaborate or work within the school projects**
29. School works with research centres and science museums to **develop initiatives using co-creative approaches, and vice versa**
30. **Visits to research centres, science centres and museums are becoming the norm**
31. **Formal procedures for stakeholder's involvement**
32. **Participation and engagement of policy makers** from key organisations in school projects and initiatives.
33. Schools show evidence of engaging in **virtual and physical platforms to develop new innovative projects, share ideas, identify and collaborate with other schools** to develop innovative projects aimed at addressing the grand societal challenges
34. **Schools projects and activities are related** to issues of national or local interest in connection with the grand challenges
35. Schools **share Open Schooling approaches with other schools and external agencies on** regional and national levels
36. Development of a **support infrastructure for teachers and students to organise local conferences, workshops, cafes, exhibitions open days** in the school with stakeholder involvement exists
37. P**ositive impact on learning outcomes** – increased student motivation, increased interest in science, achievement of higher levels of problem-solving competence and collaboration
38. P**ositive impact on learning outcomes** – achievement of higher levels of proficiency in problem solving and collaboration skills
39. The school is a **recognised site of shared science learning** in the community
40. Schools engage with **policy makers to inspire curriculum change**

3.3 R4C Validation 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 R4C National Coordinator and pilot school 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 direct data collections from the target groups while the web analytics is an indirect collection of data. The Validation Tools will be described in detail in Deliverable D4.2, with all the needed guidelines for the use.

4 Participants involved in R4C Validation Process

In this section, we describe the key actors of the Validation process that will be implemented in the framework of the work in WP4. 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 Validation process. Figure 6 illustrates the operation scheme that will be followed.

4.1 The National Coordinators

The main role of the National Coordinators in WP4 is to ensure the data will be correctly obtained and all activities will have to implement the assessment and validation following the same procedure. Additionally, the National Coordinators have the responsibility for the translation of the R4C Validation Tools if needed.

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

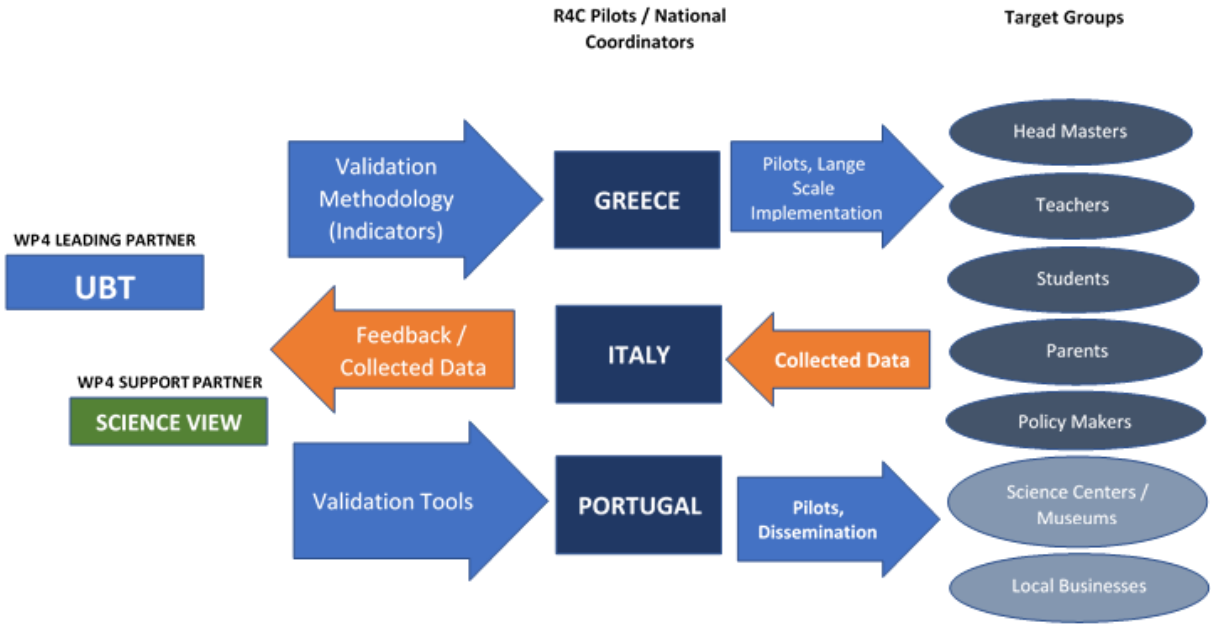

Figure 6: Target Groups and Data Flow of the Implementation/Assessment Activities.

4.2 Target groups

All the target groups that will be involved in R4C's pilot phase 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 will be collected over the web from the R4C web communities. The target groups that will be involved are:

- Head Masters and teachers from 300 schools. It is estimated that at least 1.500 school heads and teachers will be involved.
- Students from 300 schools. It is estimated that at least 15.000 students will be involved.

- Policy Makers, namely Ministries of Education and local educational authorities
- External user groups and communities: families, science groups and local sociocultural associations, affiliated science centres and museums, research centres, CSOs, local authorities, industries

5 R4C Validation Timeframe

The proposed methodology will study the expected impacts from multiple perspectives, allowing comparisons between classes that follow different teaching approaches and thus contributing in the deeper understanding of the field. As explained in the previous sections, the overall methodology will focus on the pre-post self-reflection process of the schools based on the use of the R4C Self-Reflection Tool. The school performance between the two measurements will be the reference point for the overall intervention of the project.

This section illustrates the time plan of the validation activities in the pilot schools. The period of interventions will be for one school year, starting in September 2020 and ending in June 2021. Before the starting period of the pilots the Validation Tools (D4.2) will be delivered in August 2020. During the period of May 2020 and August 2020 the Validation Team will be in contact with the National Coordinators (NCs) in order to inform them and train them (if needed) so to be able to use the tools and support the pilot schools in their countries.

The Validation process for each school to be involved in the project is starting with the population of the Self-Assessment Tool that will be developed (D4.2). After that each school should plan their activities according to the status that will be according to the self-reflection results. The R4C Innovation Model will offer several strategies, that will be delivered within the Implementation Plans (D3.1), according to their status in order to implement their plans. The R4C team will develop and deploy the school innovation profiling tool (D1.3) that will be used to profile the innovation status (starting with the self-reflection tools) of the school involved in the R4C pilot activities and for visualizing the different elements of the individual schools innovation profile for the school heads and the school innovation planning recommender system that will be used for providing recommendations (and tracking the implemented innovation pathway) to school heads and teachers for strategic school innovation based the school innovation profile.

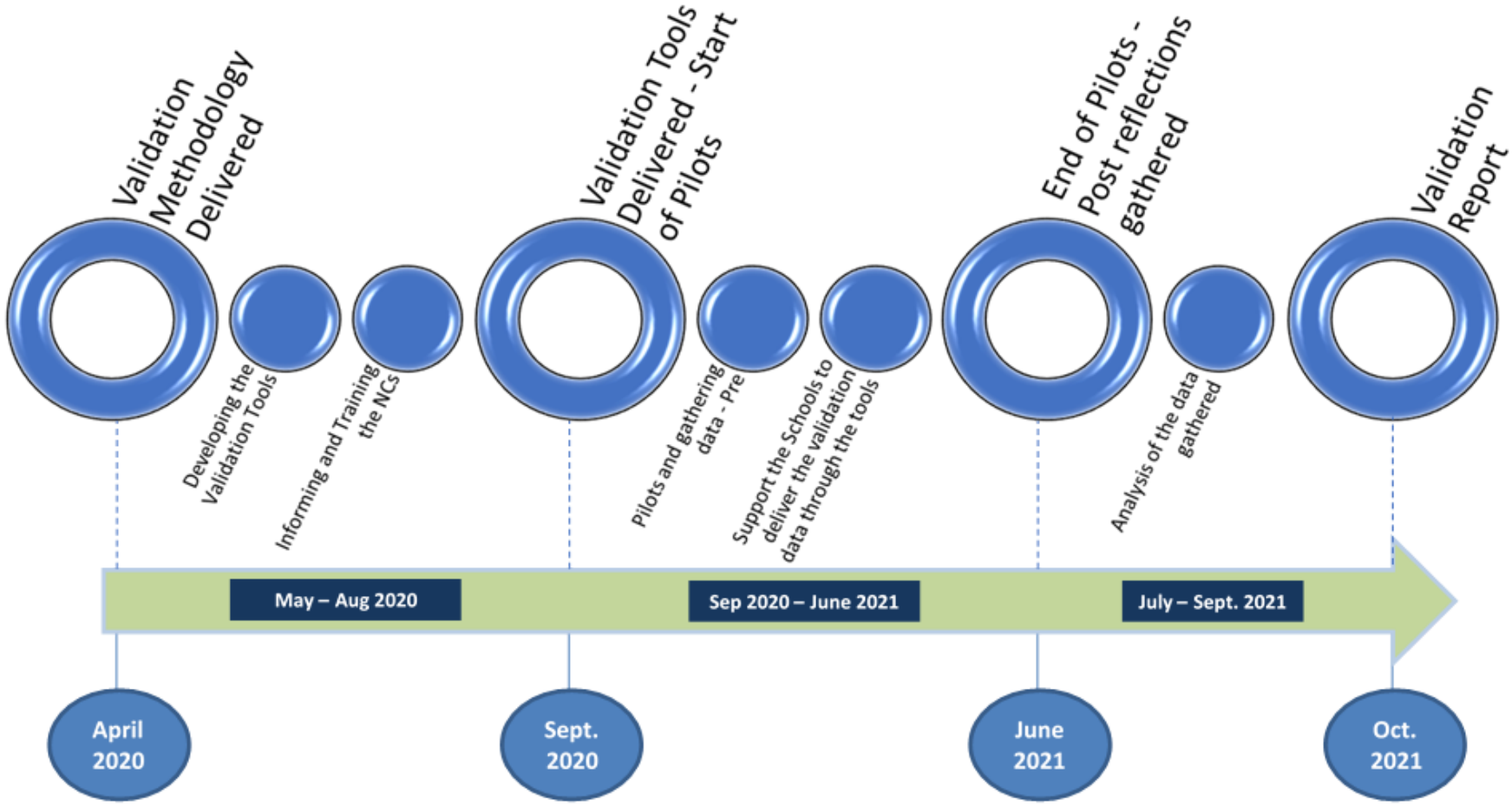

Figure 7: The timeline of the R4C Validation activities

6 Conclusions

This document describes the proposed Validation Methodology for the R4C project. The R4C Validation Methodology draws on interlinking methodologies on evaluation of school innovation on organisational changes, pedagogy approaches, e-maturity and development of digital competences approaches, science-and-society research and students' problem-solving competence, interest and motivation which align with Responsible Research and Innovation principles. The R4C Validation Framework presented offers a hybrid evaluation approach. The Impact Assessment Methodology will be based on two driving forces of the Innovation Model, on a) Progress of the School Towards Openness and b) Embedded digital Technologies.

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 innovation in 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 a 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. Organizational capacity, strategic planning and quality assurance are crucial parameters during the transformation journey. The abovementioned should be perceived from the schools during the R4C 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 R4C 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 will develop and extend a list of 40 indicators (developed from the OSOS project) to map the innovation process in the participating schools (Progress of the School Towards Openness and Embedded digital Technologies). The main tools that will be used will be Questionnaires that will be used in different situations. The most important instrument will be the R4C Self-Reflection tool. This will be the main tool to measure the organisational change in the schools. Finally, there are going to be used the data from the web analytics, data that the R4C web facilities can provide in respect to the number of communities created, number of resources and projects, number of users that participate in activities and communities etc.

Deliverable 4.1 sets the framework for the development of the Validation Instruments that will be analytically described in D4.2.

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8 APPENDIX: PREVIOUS AND CURRENT INITIATIVES IN THE FIELD

OSOS Self-Reflection Tool

The self-reflection tool was introduced in OSOS in order to measure the Organisational Change and the Openness Level of each school.

The tool is based on the three levels concerning the School's Organisational Change:

- Management Level
- Process Level
- Teacher's Professional Development Level

For each one of the above-mentioned levels the tool will reflect upon 8 aspects (items) that follow the indicators that were introduced in the OSOS project as well as the RRI aspects.

	Management Level	Process Level	Teacher's Professional Development Level
1	Vision and Strategy	School Leaders and Teachers Shaping Learning Systems	Teacher Awareness and Participation
2	Coherence of Policies	Creating an inclusive environment	Setting Expectations
3	Shared Vision and Understanding	Collaborative environments and tools (co-creation, sharing)	Professional Culture
4	Education as a Learning System	Implementing Projects	Professional Competences, Capacity Building and Autonomy
5	Responsible Research, Reflective Practice and Inquiry	Parents and external stakeholders' involvement in school's activities/projects	Leadership Competence
6	Motivation Mechanisms	Reflect, Monitor, Debate	Collaborative learning (mobility actions)
7	Plans for Staff Competences	Learning Processes adaptation	Collaborative learning (ICT Competences)
8	Communication and Feedback Mechanism	Established collaboration with local, national institutions	Use and reuse of resources

For each one of the 8 aspects in each level the school has to choose one statement that correspond to the actual situation at the time. Each statement corresponds to a school typology, according to the school's readiness to adapt an open schooling culture.

After the completion of each one of the required sections of the self-reflection tool, the School Head (the school) is getting a report that includes the answers in each one of the sections as well as the results of the reflection. The report presents their answers as a table for each one of the sections as well as informs about the status in relation to its openness. There are four categories where a school will be categorised:

- Enabled (0-25%)
- Consistent (25-50%)
- Integrated (50-75%)
- Advanced (75-100%)

Along with the results, concerning the category in which belong, the school heads and/or the individual teachers are informed in practical terms for:

- the tailored OSOS Strategies to support the local schools as they transform themselves into open schooling environments
- the package of the supporting services that they could use (accelerators)

R4C Team will be based on the OSOS SRT in order to develop the R4C Self-Reflection Tool.

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, R4C can utilise this scoring mechanism for the online platforms. **SELFIE is therefore a guiding influence for data collection around technology adoption and use and main aspects will be integrated in the R4C Self-Reflection Tool.**

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 R4C 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 R4C.**

Inquiry-based Science Education (IBSE) is an open system of pedagogical tools that suits the R4C system, and can be seen as the origins of how RRI and open schooling can occur in the R4C 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 R4C innovation 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 ISBE. 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 Vygostsky 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 R4C Innocation 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 heard 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 R4C. 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 R4C**.

The wider RRI research agenda

EnRRICH is A 4-year H2020 project to network institutions that are introducing RRI into third level curricula **u**sing pilot projects of community- projects**.** A particular strength – with respect to R4C 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 R4C approach especially in respect of the Organisational Change that R4C would like to introduce to schools (Progress of the School Towards Openness).

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 R4C 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 R4C. 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 R4C 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 R4C Validation Methodology 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 WP4 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 R4C 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 R4C 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 R4C 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 students 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 R4C 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 R4C 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 R4C 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. **The entrepreneurial spirit of innovation and consideration for local economy and Valuation will also be guided by this project.**