R4C

Reflecting for Change

Deliverable 4.2

Validation Tools

Co-funded by the
Erasmus+ Programme
of the European Union

Document Control Page

WP/Task	WP4 / T4.2
Title	D4.2 Validation Tools
Due date	31/08/2020
Submission date	31/08/2020
Abstract	This document outlines the Validation Tools (impact assessment tools) for the R4C project. It follows the Validation Methodology and Plan, D4.1 and presents the tools that will be used during the pilot phase of the project in order to collect the needed feedback from the activities in the R4C schools. Different methods and techniques are employed, including a mix of quantitative and qualitative methods such as document and statistical analysis, interviews, focus groups, tracking of student interest/progression via surveys of pre-post reflections. This ensures that different perspectives are considered to heighten the quality and the validity of the overall evaluation.
Author(s)	Menelaos Sotiriou – Science View
Contributor(s)	Franz Bogner – University of Bayreuth, Sofoklis A. Sotiriou – Ellinogermaniki Agogi
Reviewer(s)	Nikos Zygouritsas – Ellinogermaniki Agogi
Dissemination level	☐ internal ☒ public ☐ confidential

Document Control Page

Version	Date	Modified by	Comments
01	30/06/2020	SV	1st draft delivered by SV (Structure)
02	30/07/2020	SV/EA/NUCLIO/UBT	Integration of comment/input from SV, EA, NUCLIO and UBT SV: Self Reflection Tool EA: Web analytics NUCLIO: Comments and updates for the Self Reflection Tool UBT: SMQ and IMI Questionnaires
03	30/08/2020	SV	Final Version

Executive summary

This document describes and presents the R4C Validation Tools. It follows the Validation Methodology that was presented in D4.1. The tools will be used throughout the project's duration in order to give feedback and assess the school innovation as well as the science education approaches on evaluating students' interest and motivation in science which align with Responsible Research and Innovation (RRI) principles.

The deliverable provides the needed descriptions on how to use the tools as well as the methods that will produce results. It contains practical information on the use of questionnaires as well as information on the collection of target groups feedback. Additionally, the regular reporting mechanism which will help address any issues as they appear is described.

Following the Validation Methodology, the tools (self-reflection tools, questionnaires, interviews and focus groups guidelines) will validate the R4C School Innovation Model and Strategies during the implementation phase with 300 schools in 3 European countries (Greece, Italy and Portugal).

In Chapter 1 the overview of the tools that will be used is presented, by corresponding each tool to the indicator that will measure. There will be 2 main categories of the assessment and the tools that will be used (1) to measure how the Schools Work according to the R4C School Innovation Model and (2) to measure if there is an increase in the motivation and interest of students while following the R4C proposed activities. The rationale or the development of the assessment tools for the first category is presented, namely the Self Reflection Tool and the School Development Plan. For the second category, already existing tools that have been tried in several relevant occasions, will be used and therefore are shortly presented in this section.

In Chapter 2 the R4C Validation Tools are presented in detail. The reasoning behind their development and how they will be used is presented along the main contents of the tools (questions, statements, guidelines etc.). The Validation tools will be used to measure the Organisational Change and at the same time the Pedagogical Impact of the proposed approaches and activities. The main tools presented, are Questionnaires that will be used in different situations. The most important instrument is the R4C Self-Reflection tool. This will be the main tool to measure the organisational change (in respect to innovation, openness and e-maturity) and the RRI integration in the schools and is structured in such a manner that gives the opportunity to each school to identify the status and the level of innovation according to the R4C School Innovation Model. The students of the participating schools will also have to fill in questionnaires according to the activities that they are going to realise in order to measure their motivation and interest. Furthermore, validation approaches that will give valuable feedback, like interviews and focus groups, as well as, data that will be gather through the web infrastructures that will be used during the project, are presented also in this chapter.

Table of contents

1 Introduction

1.1 Assessing School's Innovation

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 Visualization will help school heads to develop their strategy.

The development of the R4C Validation Framework (D4.1) 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.

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

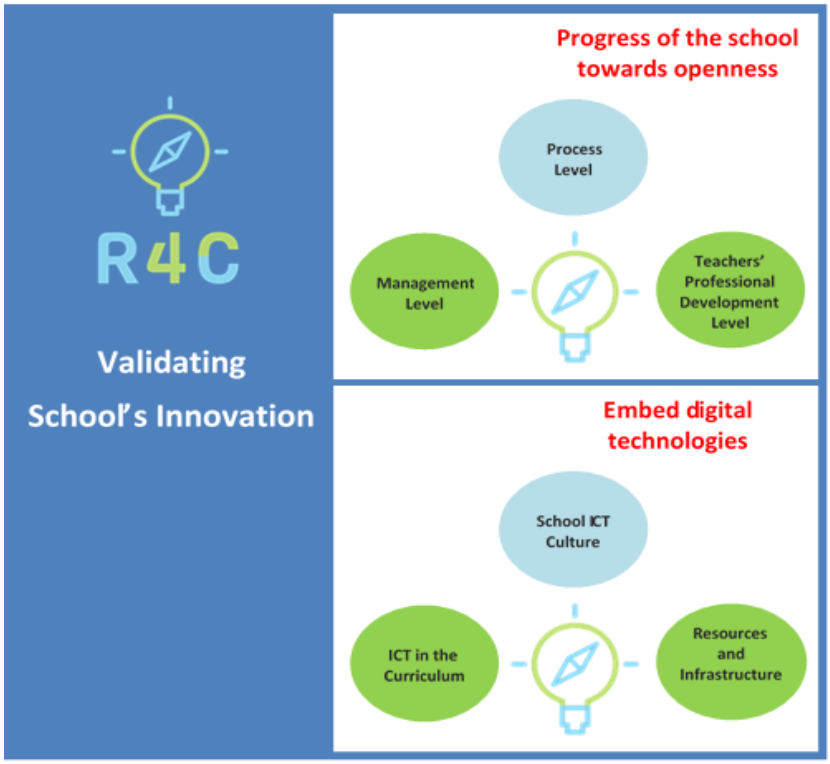


Figure 1: *The overall validation framework for monitoring the R4C Schools' Development during the implementation phase*

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.

1.1.1 Measuring the Organisational Change and RRI Integration

To measure the Organisational Change and the RRI Integration, the R4C Assessment Team developed a **Self-Reflection Tool** that is based on 3 levels:

- The Management Level
- The Process Level
- The Teachers' Professional Development Level

Each Level includes 8 items that cover in each level relevant issues like leadership and vision, processes and how are implemented as well as the school staff competences and how they are included in the strategy of each school. The aspects include also RRI characteristics that the school needs to integrate in its structure and development plan.

The Development Plans that each school will develop will be used also in the Assessment of the project in order to cross check the planning with the responses in the self-reflection tool.

Both tools will be used in order to measure the Indicators 1 to 20 as it is illustrated also in the Table 1 below.

1.1.2 Measuring the impact on science pedagogy

The OSOS Accelerators and the OSOS Platform will provide the means and the tools along with the necessary collaborative and personalisation functionalities to introduce learners in extended episodes of deep STEM learning related activities.

During the pilots the schools will implement several activities in schools as well as in the OSOS platform. Our aim is to explore some key characteristics of the related science pedagogy by focusing on **students' motivation and interest**.

In Chapter 2 are presented the relevant questionnaires that will be used to measure the impact on science pedagogy:

- Science Motivation Questionnaire II (SMQII)
- Intrinsic Motivation Inventory (IMI)
- State Emotions (SE)
- Cognitive Load

1.1.3 Shallow and Deep Web Analytics

Shallow and deep analytics will be provided from the R4C as well as OSOS platforms. These will be used to support teachers for their professional development as well as students learning and achievement as well as the design of more effective educational experiences for the students.

The main analytics that will be used are:

- Number of communities that the teacher participates in
- Number of communities that the teacher creates
- Number of educational resources that the teacher creates
- Number of school projects that the teacher creates
- Number of webinars that the teacher participates in
- Number of summer schools that the teacher participates in
- Users Behaviour
- Time on Task
- Educational Value of the Resource
- Class Profile
- Competence Proficiency

To gather the data mentioned above will also contribute the Implementation Reports tat will be gathered through the National Coordinators.

1.1.4 Matching R4C Indicators to Validation Tools

Table 1 contains the updated list of indicators that were presented in D4.1. These indicators are presented with corresponding tools for each one of them (or group of them) and will be used to measure them.

Table 1: *Matching R4C Indicators with Validation Tools.*

Driving Forces	Evidence of Openness and Growth	Indicators	Instruments (tools) to be used
Rethinking How Schools Work	**Holistic school approach and vision**	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** 9. **Parental engagement is integrated** into the school planning structure	• R4C Self-Reflection Tool • R4C Development Plan • Web Analytics • Implementation Reports
	Effective introduction of RRI principles in the school operation	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	
	Effective and sustainable partnerships with external stakeholders	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. V**isits 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.	• R4C Development Plan • Focus Groups and Interviews • Web Analytics • Implementation Reports
Shift from Students as Consumers to Creators	**Educational resources generated in school settings according the local needs**	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	• Web Analytics • R4C Development Plan • Implementation Reports

		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	
	Increased Interest and Motivation	37. P**ositive impact on learning outcomes** – increased student motivation, increased interest in science, achievement of higher levels of problem-solving competence and collaboration	Questionnaires: • SMQII • IMI • SE • Cognitive Load
	Development of key skills	38. P**ositive impact on learning outcomes** – achievement of higher levels of proficiency in problem solving and collaboration skills	• Web Analytics • Implementation Reports
	Focused policy support actions	39. The school is a **recognised site of shared science learning** in the community 40. Schools engage with **policy makers to inspire curriculum change**	• Focus Groups and Interviews • Implementation Reports

2 R4C Validation Tools

2.1 Validating School's Innovation

2.1.1 R4C Self -Reflection Tool

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.

2.1.1.1 Presenting the tool

The tool is based on the three levels that were presented in D4.1 concerning the School's Organisational Change in respect to innovation:

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

For each one of the above-mentioned levels the tool will reflect upon 8 items that follow the indicators that were introduced in section 1.1.4 as well as the RRI aspects.

Table 2: The Three Levels of change of R4C 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

For each one of the 8 items 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, as it was introduced in D4.1 according to the school's readiness to adapt an innovation schooling culture.

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

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 external partners to facilitate the process	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

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 innovation status. 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 (presented in D3.1) 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)

In the following table we present all the statements that the School will need to select from in order to implement the Self-Reflection Tool.

		Enabled	Consistent	Integrated	Advanced
MANAGEMENT LEVEL	**Vision and Strategy**	The school is, or will start, planning to develop a strategic plan in order to become an open school. The plan will also ensure the students and teachers will have the necessary access to ICT equipment and internet (provided by the school or bringing their own devices).	The school has already developed a vision on how to become an open school. Mechanisms for implementations of the vision are being currently developed and teachers are invited to participate in the process. The focus of the schools is not only to ensure the necessary infrastructure is available but also to have a dedicated ICT coordinating teacher with clearly defined roles and responsibilities in place.	Innovation and Open Schooling is part of the school vision and activities are being implemented following the School Innovation Approach. ICT is included in the vision and strategy of the school focusing on the enhancement of learning and takes into account the necessary inclusive aspects through assistive technologies and appropriate ICT resources in addressing students additional or differentiated learning support.	The school innovation approach is already integrated in all the activities of the school. There is a dedicated support team to maintain the ICT infrastructure and ensure proper updating of the existing software. The foreseen student/ computer ration is 3 students per computer or less and the school is committed to provide internet connection throughout the school. Students can bring their own devices to school.
	Coherence of Policies	The school management ensures or will ensure that the school policies are coherent to the latest developments and also to the needs of the students, the teachers and the general community of the school. The school's policies clearly address or will address the integration of ICT infrastructure and resources.	The school considers comprehensive strategies to raise the quality in the teaching inside the organisation, including school leadership and the attractiveness of careers at school, covering such aspects as teacher competences, qualification requirements, a continuum of teacher education and professional development, teacher evaluation, career perspectives and working conditions. The school considers the integration of Technology Enhanced Learning in a wide range of curricular areas.	The school critically reviews and aligns its policies with any major changes to curricula, assessment, school organisation and funding, quality assurance etc., to ensure coherence in line with central policy objectives in school education; Technology Enhanced Learning is integrated in the school policy and foresees the existence of assistive technology and appropriate resources to promote cross curricular learning opportunities.	The school involves policy makers and education organisations in an open and regular dialogue with the goal of increasing policy coherence and to benefit from stakeholders' experience and broad networks. There is a well-established policy for safety and acceptable use of the internet. Technology Enhanced Learning (TEL) opportunities are integrated in teachers' daily practices, to ensure equity and equal opportunities to all students. TEL is integrated in the school policy promoting inclusive, cross-disciplinary and differentiated learning opportunities.
	Shared Vision and Understanding	The school has a or is designing a common vision for open schooling that is or will be shared among the teachers. Technology Enhanced Learning integration is or will be shared among the teachers	The school enables means to gather perspectives from different levels of the system including central authorities, national stakeholder organisations; regional/local authorities and stakeholders, practitioners at school, pupils with their parents and families, local communities; The school uses an ICT vision to gather and organize information from within and outside the school, that is understood and shared by all stakeholders.	The school balances school autonomy with measures for evaluation that support school development and help teachers and school leaders to shape their school as a learning organisation, review quality assurance systems and the role of inspection in this respect ICT is the favoured mean to assess the impact the development plan of the school and the impact on students' learning.	When defining policies and priorities for Continuing Professional Development, the school considers balancing needs at system and school levels while also considering the needs of individual teachers and school leaders ICT is used to enable a continuous self-evaluation of teacher's needs and to facilitate the design of the school priorities with the support and participation of all members of the school community at large, including the needs of the local community.
	Education as a Learning System	The school creates, or will create, a vision to support members of the school community to adopt changes in order to improve the organization as an overall. School heads participate in professional development to	The school builds capacity for change management, including the identification of change leaders, offering them professional development on change management, and other forms of support. Professional	The school sets up broad and inclusive consultation processes, to build trust and enhance support for reforms among stakeholders, and to inform policy-making;	The school considers regional or local partnerships to stimulate school development and change or support the implementation of specific changes and

		Enabled	Consistent	Integrated	Advanced
		support individuals to improve their own competence profile, aligning it with the vision of the school.	development is provided to support the management of the changes not only in a person to person basis but at an organizational level as an overall.		reforms, e.g. model regions, best practices from local networks, etc.
	Responsible Research, Reflective Practice and Inquiry	The school introduces or will introduce the principles of responsible research, reflective practice and inquiry in the school practices	The school supports teachers in gaining research qualifications and conducting research, for instance by recognising and encouraging research as part of professional development; or through grants for research projects or qualifications (e.g. PhD);	The school supports reflective practice to develop learner-centred teaching and assessment strategies; It rewards and stimulates innovation in teaching, and school practice more generally, for instance through grants, awards;	The school creates partnerships between schools and higher education institutions, focused on research, feedback loops between theory and practice (involving both teacher education providers and faculties of educational science); It instigates and develops training for peer-mentoring.
	Motivation Mechanisms	The school plans to set-up a mechanism aimed at motivating teachers and students to undertake innovative projects.	The school has already set a mechanism to motivate teachers and students to undertake innovative projects	The majority of the teachers and students demonstrate a motivation to undertake innovative projects.	The school's motivation mechanism is evaluated and updated in regular base. The use of ICT as a motivation mechanism is used regularly in the school.
	Plans for Staff Competences	The school develops or will start developing a plan to identify Teachers' Professional Development needs.	The school has appointed a teacher or a team of teachers as responsible to identify and plan the whole school staff Professional Development needs. Technology Enhanced Learning is suggested as a mean to develop knowledge on curriculum activities in their schools and other schools	The school is realising or participating in Teachers' Professional Development programmes.	The school regularly updates the plan for the Staff Professional Development programme according to a needs analysis mechanism.
	Communication and Feedback Mechanism	The school is working on a communication plan with a concrete set of actions and target audiences. The plan includes or will include a mechanism to communicate its Innovation vision and strategy to all the stakeholders. The school has or is planning to have an online presence (Website, social media channels, etc) as a mean to communicate with the school and local community	The school communication plan takes into consideration the different target audiences from the school (staff, teachers and students) and local communities and has a team responsible for its design and follow-up. School Management communicates the vision and its Innovation Strategy to the whole school community. The online presence of the school is part of the strategy and a key component to the materialization of the vision.	The school communication plan created with the support of members of the school has a clear selection of channels in order to ensure the full involvement of the whole school and local community, including other stakeholders such as education authorities and local business. The open schooling vision as well as major development and participation in projects are regularly shared with the communities (students, teachers, families, etc.). There is a specific area in the school website where all the important projects and developments are openly shared.	Besides the integrated communication and feedback mechanism, the school communication plan has a clear definition of all actions, channels and target audiences and is co-created with the members of the school and local community. Continuous evaluation of the plans impact is conducted and the necessary adaptations integrated in the plan. A dedicated group of teachers is in charge of the website updates and social media sharing of all major developments and milestones achieved by the school.

		Enabled	Consistent	Integrated	Advanced
PROCESS LEVEL	**School Leaders and Teachers Shaping Learning Systems**	School leaders and teachers have or will have their expertise recognized and mandated to contribute to everyday school activities.	The school creates opportunities for school staff to diversify careers by taking on additional roles, at school (coordinating or leadership roles; support to colleagues, including mentoring, professional development, involvement in school development, (international) project work, extracurricular activities, cooperation with external partners);	The school creates opportunities for school staff in general to become involved in developing the School Innovation approach (school evaluation; policy dialogue; policy development etc.)	The school creates opportunities to encourage and support school staff to engage in school-to-school networks to share expertise and teaching resources, spread innovation and support school development Students are invited to collaborate with students from different schools (at a national and international level) and the school as whole is invited to participate in a series of activities and challenges. Micro accreditation mechanisms such as digital badges are a common practice in the school.
	Creating an inclusive environment	The school has identified, or will identify, the national or European guidelines concerning inclusiveness. The school's strategic plan takes, or will take into consideration those guidelines.	Some teachers are implementing inclusive activities that take into consideration aspects of communication, awareness, equal opportunities, gender balance, and avoid any stereotypical language and behaviours.	Most of the teachers are implementing inclusive activities that take into consideration communication, awareness, equal opportunities, gender balance and avoid any stereotypical language and behaviours). As part of these actions several community problems have been targeted and identified (social, gender, cultural, religious, etc.).	The majority of teachers is implementing inclusive activities that take into consideration: communication, awareness, equal opportunities, gender balance and avoid any stereotypical language and behaviors and collaborate with schools at local or national level in the targeting of related community problems. Students help identify and propose solutions to such problems (social, gender, cultural, religious, etc.)
	Collaborative environments and tools (co-creation, sharing)	The school sets-up or will start setting-up the needed infrastructure to enable teachers and students to create a collaborative working environment.	Teachers and students are using collaborative environments for some classroom activities. Teachers co-create materials with their colleagues and with the participation of students.	Teachers and students are regularly using collaborative environments in their classroom activities and are also developing and sharing content Teachers collaborate and work in an interdisciplinary way. Students use ICT within school hours to collaborate and to acquire knowledge within their school environment and also externally with other schools. A cooperative approach for producing and sharing activities is in place.	Teachers and students regularly use collaborative environments in their classroom activities and co-create content with other schools. Teachers promote cross-disciplinary activities, and project-based learning opportunities. The community at large is welcome to participate in the collaborative projects and help in its creation and sharing process.
	Implementing Projects	The school is implementing or will implement one or more projects, in at least one classroom, targeting the involvement of the community.	The school will implement or is implementing more than one project in several classrooms, targeting the involvement of the community. The school includes dissemination of their participation projects.	The majority of teachers participate and disseminate their participation in national and international projects, in particular those addressing the involvement of the community. There is collaboration among teachers of different disciplines and they actively disseminate their projects as part	Teachers create new projects and coordinate the participation of several classrooms in it, including a cross-grades participation. The projects are cross-disciplinary and open to members of the school and local community. Teachers support the dissemination of their projects

		Enabled	Consistent	Integrated	Advanced
				of the school's communication plan. All projects are following the school inclusion strategy and make good use of Technology Enhanced Learning opportunities.	as part of the co-created school's communication plan. All projects are following the school inclusion strategy and make good use of Technology Enhanced Learning opportunities.
	Parents and external stakeholders' involvement in school's activities/projects	Parents (guardians, family) and external stakeholders' engagement is, or will be, evidenced through projects that the school has initiated.	Parents (guardians, family) and external stakeholders' engagement is embedded in most of the school's activities.	Parents (guardians, family) and external stakeholders' engagement is embedded in most of the school's activities and the school has initiated an ongoing monitoring and evaluation of their interventions.	Parents (guardians, family) and external stakeholders' engagement t is embedded in all the school's activities and show initiative in this participation. An ongoing monitoring and evaluation of their interventions is established. The school has a specific mechanism to identify all the major infrastructures existing in the locality (science centres, industry, service providers, etc) and how they can support and collaborate in the materialization of the school's vision and mission.
	Reflect, Monitor, Debate	The school conducts or will conduct reflection, monitoring and debates as part of the school's activities (involving teachers and students). These tasks are performed on components that have been identified as critical to the implementation of the School Innovation Strategy.	The school performs regular analysis and evaluation of the data collected from the reflection, monitoring, and debates with teachers and students. ICT is used to reinforce the process and assessment the students' progression.	The school produces regular reports on the findings of the reflection, monitoring and debates with teachers and students, including the assessment of students' progression with a component of self-assessment. The reports are distributed to teachers, students, parents as well as the school management and relevant improvements are realized based on it.	The school produces regular reports on the findings of the reflection, monitoring and debates with the whole school community as well as with external stakeholders. The reports are distributed to all the stakeholders and relevant improvements are integrated in the school's development plan.
	Learning Processes adaptation	0 to 25% of teachers show evidence of adapting learning processes according to results of their previous experience.	26 to 50% of teachers adapt learning processes according to established feedback mechanism involving all stakeholders. Teachers use ICT as a mean to increase pupils' motivation and improve their competence profile. The main focus for students with special needs is on literacy and numeracy	51 to 75% of teachers are adapting learning processes according to established feedback mechanism involving all stakeholders. Students can work online and their progress can be monitored. ICT tools are used to communicate with the students in the process and to adapt differentiation to accommodate the different needs of their students.	All teachers and students propose improvements and adaptations according to feedback from all stakeholders, regularly. Teachers use ICT to assess the evolution of the students using Learning Analytics, ePortfolio or other similar technologies. ICT solutions are available to all students with special needs and are used in a cross disciplinary format.
	Established collaboration with local, national institutions	0 to 25% of teachers collaborate or will collaborate with local and/or national research/science institutions	26 to 50% of teachers implement projects with the collaboration of local and/or national research/science institutions and other businesses and industries in their region.	51 to 75% of teachers are implementing projects with the collaboration of local and/or national research/science institutions and other businesses and industries in their region.	Collaboration with local and/or national research/science institutions and other businesses and industries in their region, is embedded in all the school's activities. An ongoing monitoring and evaluation of interventions is established.

		Enabled	Consistent	Integrated	Advanced
TEACHERS' PROFESSIONAL DEVELOPMENT	**Teacher Awareness and Participation**	Teachers are or will be introduced, and offered to engage in Professional Development opportunities.	Teachers are aware of and many have participated in Professional Development programmes (e.g. Summer Schools, Mobility actions)	All teachers are aware and the majority of the teachers have participated (individually or as whole school) in Professional Development programmes.	All teachers meet their professional needs through active participation in communities of practice, peer to peer networks and accredited practice-based research
	Setting Expectations	The school sets, or will start setting, a framework of clear and tangible expectations for each member of the school community	The school creates transparency on the competences required from teachers and other staff at different stages of their involvement through frameworks or standards	The school involves teachers and other relevant stakeholders in its development and regularly reviews its strategy to ensure ample acceptance, relevance and usefulness	The school ensures that expectations are set out in the school framework and that clear and tangible expectations for each member of the school community are aligned with national policy and curricula as well as with the schools' own curricula and goals.
	Professional Culture	The school will or is already encouraging and supporting collaboration among staff for teaching (e.g. team teaching; sharing of teaching resources) and staff learning. The school is working, or will work, on a team building strategy.	The school encourages cross-school networks and digital platforms to support (a culture of) collaboration in the teaching profession. The school invests in a series of team building activities as part of their strategic plan. The activities are implemented in collaboration with other school's networks.	The school supports a culture of collaboration by avoiding situations that could encourage counterproductive competition between individuals. The school strengthens recruitment and retention of qualified staff by focusing on school ethos or professional culture. Team building activities are integrated in the whole school vision and involves not only teachers and students but also other staff members of the participating schools.	The school encourages links between schools and providers of teacher education; It supports systematic induction of beginning teachers, and teachers new to the school. Besides the integrated vision for team building activities, members of the school and local community participate in the co-creation of the strategy.
	Professional Competences, Capacity Building and Autonomy	The school clarifies, or will clarify, the definition of CPD (Continuous Professional Development) for school staff, with a preference for a broad, open and inclusive concept that is operational at the same time (including formal, informal and non-formal forms of professional learning). Teachers are encouraged to include the use of ICT in their training.	The school considers making CPD an obligation/explicit duty, and allocating working time to it. Teachers are encouraged to integrate TEL in their training, including the curriculum opportunities for its use in classroom.	The school aligns priorities with real needs at different levels (teachers' individual learning needs, school level needs,) and review systems of priority setting if needed (at which level, by whom) It encourages professional development cultures at school: this may include reviewing decision-making on priorities and funding allocation; the use of CPD plans by schools/individual teachers; links to teacher appraisal. The use of digital tools and resources to facilitate the whole process is included across the training opportunities.	The school supports self-regulation of the profession (e.g. through a teaching council or consultation processes). Schools staff is invited to share their training and implementation experience in a collaborative way. The use of a variety of different software and Open Education Resources is incentivized.
	Leadership Competence	The school creates, or will create, transparency on the competences required from school leaders, for instance through competence frameworks or standards	The school ensures transparency and common understanding on the leadership competences of teachers (at different stages of their career)	The school reviews teacher education, including CPD available to ensure it addresses leadership competences	The school promotes forms of distributive leadership with broad involvement of staff at school

		Enabled	Consistent	Integrated	Advanced
	Collaborative learning (mobility actions)	There is no or limited sharing of innovative practices among the teachers of the school	Teachers in the school are sharing and collaborating in innovative projects in an informal manner	Teacher regularly share their innovative projects and collaborate within the school as well as with other schools	School supports and facilitates peer to peer learning in open schooling practices through mobility actions and other formal approaches.
	Collaborative learning (ICT Competences)	Professional Development is or will be focused at least on basic ICT skills	Some teachers participate in Professional Development Programmes aimed at introducing collaborative learning through digital platforms	The majority of teachers participate in Professional Development Programmes introducing collaborative learning through digital platforms	School identifies and designs its whole school Professional Development programme for collaborative learning through digital platforms, shared also with other schools.
	Use and reuse of resources	Teachers are, or will be, offered the opportunity to engage in web communities and avail of online resources to support teaching practices	Teachers in the school use online resources and share self-developed resources.	Teachers regularly uses online resources from web communities and portals in their classroom.	Teachers confidently share their online resources within their own school and with other schools.

2.1.1.2 Implementation Process

The school representative through the R4C webtool (http://srt.reflecting4change.eu/), will have access to the R4C Self Reflection Tool. He/She will have to fill in each one of the 3 levels and to choose between the statements that correspond to the school's status. Each one of the 8 items of each level will be presented as in Figure 2 and the school representative will have to choose between the 4 statements in each item:

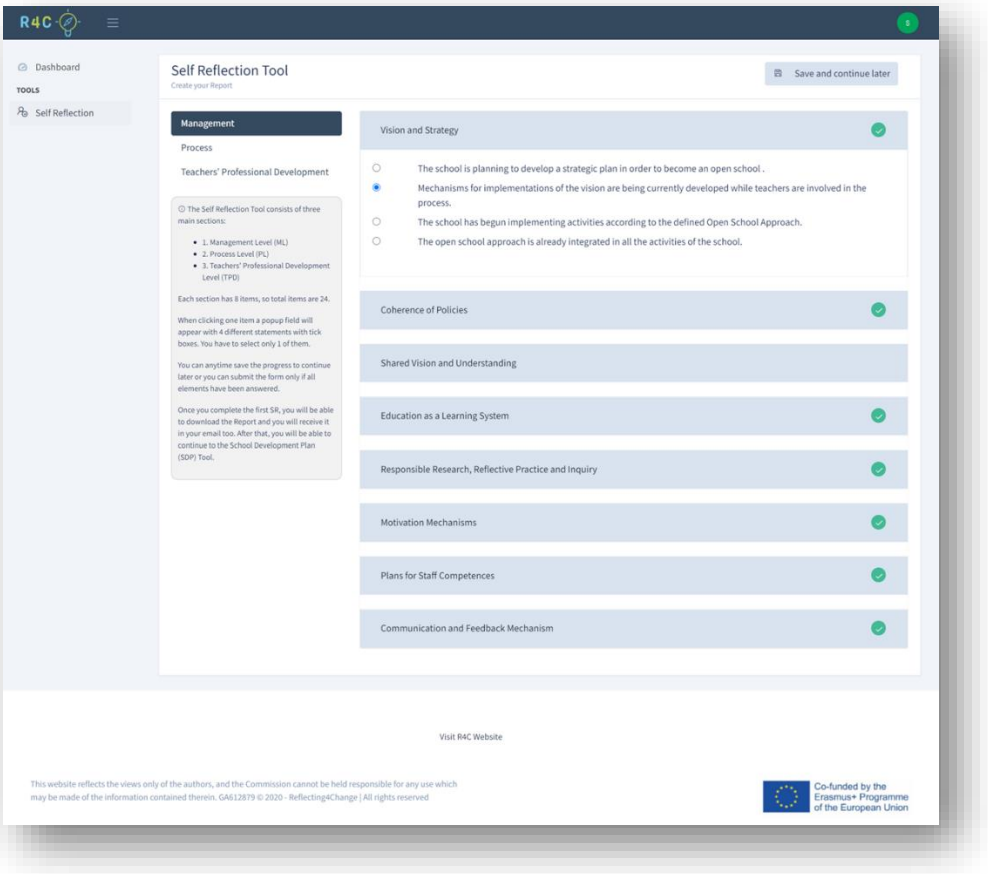


Figure 2: *The SRT environment that each school will use in order to reflect on its innovation status.*

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 (see Figure 3) as well as will inform about the status in relation to its innovation. As it was presented in the previous section 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 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)

An example of the report that will be produced is illustrated in Figure 3.

Figure 3: *Example of the R4C Self Reflection Report that the school will receive after fill in the Self Reflection Tool.*

The Self-Reflection Tool will be realized from each school participating in R4C at the beginning of its involvement and then at the end of the R4C Implementation activities.

2.2 School Development Plan

2.2.1 Presenting the tool

The R4C participating schools will be asked to cater for a holistic school development plan in using a provided template. That plan 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 School Development Plan Template is presented in Appendix 1. It will be used in the framework of the implementation phase (detailed instructions on the use are presented in D3.1) after the school will fill in the Self Reflection Tool and before it starts to realise activities. The Development Plan will be used from 300 schools from the participating countries.

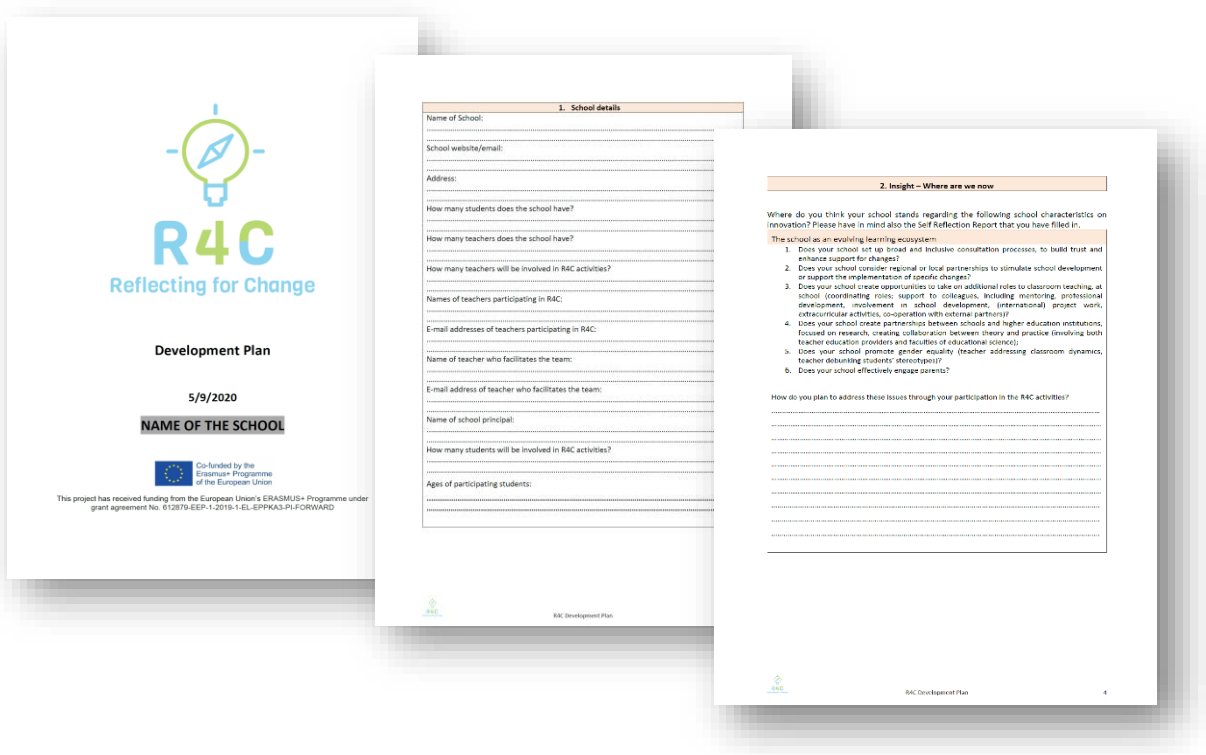


Figure 4: *Sample sections of the R4C Development Plan Template.*

The implementation of a School Development Plan is valid here. It could be a helpful tool for the school management who has to be committed to change to initiate a series of activities that will help the educational staff to realize the added value of the innovation process.

The School Development Plan will be used in order to cross check the schools' planning with the actual activities that will undertake during the implementation phase.

2.3 Measuring the impact on students' motivation and interest

2.3.1 Description of motivation, emotion and cognitive load measures

2.3.1.1 SMQ Science Motivation Questionnaire

In general, motivation is the internal state that arouses, directs, and sustains goal-oriented behavior (Glynn, 2011). In particular, motivation to learn refers to the disposition of students to find academic activities relevant and worthwhile and to try to derive the intended benefits from them (Brophy, 2004). In studying the motivation to learn science, researchers examine why students strive to learn science, how intensively they strive, and what beliefs, feelings, and emotions characterize them in this process.

In the social-cognitive theory of human learning (Bandura, 2001, 2005, 2006), students' characteristics, behaviors, and learning environments are viewed interactively. Within this theoretical framework, learning is most effective when it is self-regulated, which occurs when students understand, monitor, and control their cognition, motivation, and behavior (Schunk, 2001; Schunk & Pajares, 2001). Motivated students achieve academically by strategically engaging in behaviors such as class attendance, class participation, question asking, advice seeking, studying, and participating in study groups (Pajares, 2001, 2002; Pajares & Schunk, 2001).

First, there is **intrinsic motivation**, which involves learning science for its own sake (e.g., Eccles, Simpkins, & Davis-Kean, 2006).

Second, there is extrinsic motivation, which involves learning science as a means to an end (e.g., Mazlo et al., 2002).

Third, there is personal relevance, which is the relevance of learning science to students' goals (e.g.,Cavallo et al., 2003).

Fourth, there is self-determination, which refers to the control students believe they have over their learning of science (e.g., Black&Deci, 2000).

Fifth, there is **self-efficacy**, which refers to students' confidence that they can achieve well in science (e.g., Lawson, Banks, & Logvin, 2007).

And sixth, there is **assessment anxiety**, which is the debilitating tension some students experience in association with grading in science (e.g., Parker & Rennie, 1998).

A construct, such as motivation to learn science, is not a directly observable variable. For this reason, a construct is often called a latent variable. Although a construct cannot be directly observed, it can be measured by means of items that serve as empirical indicators of how the construct is conceptualized by students. A construct could be conceptualized by students either as a unitary entity or as one with dimensions (sub-constructs). Students' conceptualizations of a construct may differ somewhat from how experts conceptualize it and describe it in the literature (Donald, 1993). Students' conceptualizations are important in their own right, however, particularly within a social-constructivist view of learning science, because students' conceptualizations influence their actions (McGinnis et al., 2002; Scott, Asoko, & Leach, 2007).

The Science Motivation Questionnaire II (Glynn) consisted of the following five subscales/factors, indicating that they were related to the six motivational components that influence self-regulated learning. Factor 1: intrinsic motivation; Factor 2: self-efficacy; Factor 3: self-determination; Factor 4: career motivation; Factor 5: grade motivation (each 5 items).

The students found science intrinsically motivating (interesting, enjoyable, etc.) when it was personally relevant (valuable, important, etc.) and vice versa. When the students' had high self-efficacy (I am confident, I believe I can, etc.), they were not anxious about assessment (I am nervous, I worry, etc.), and this was evident in their explanations of their motivation to learn science.

Glynn found **no significant differences in total scores** on the Science Motivation Questionnaire due to **gender**; however, there were small, meaningful score differences on the factor-based scales, which indicated that different profiles of motivation to learn science were associated with gender. The scores on the **self-efficacy and assessment anxiety scale** were **higher among the men then the women**, suggesting that the men had more confidence and less anxiety than the women did.

For our young participants we have to consider which sub-scales of the SMQII are focused. Originally the SMQ was designed for university freshmen (Glynn, 2011). Schmid & Bogner (2017) and Schumm &Bogner (2016) have shown that this survey is suitable for students in grade 9 and 10. Marth & Bogner (2017) have inserted this instrument in the transition passage from primary to secondary school students. Finally, the questionnaire could be inserted in all age groups and show good results.

The SMQ II survey may deal with following questions:

- Do specific R4C activities influence the students' science motivation?
- Could the motivation to learn science be raised?
- Are there gender differences?

2.3.1.2 Intrinsic Motivation Inventory (IMI)

The Intrinsic Motivation Inventory (IMI) is a multidimensional measurement device intended to assess participants' subjective experience related to a target activity in laboratory experiments.

It has been used in several experiments related to intrinsic motivation and self-regulation (e.g., Ryan, 1982; Ryan, Mims & Koestner, 1983; Plant & Ryan, 1985; Ryan, Connell, & Plant, 1990; Ryan, Koestner & Deci, 1991; Deci, Eghrari, Patrick, & Leone, 1994). The instrument assesses participants' interest/enjoyment, perceived competence, effort, value/usefulness, felt pressure and tension, and perceived choice while performing a given activity, thus yielding six subscale scores.

The interest/enjoyment subscale is considered the self-report measure of intrinsic motivation; thus, although the overall questionnaire is called the Intrinsic Motivation Inventory, it is only the one subscale that assesses intrinsic motivation, per se. As a result, the interest/enjoyment subscale often has more items on it that do the other subscales. The perceived choice and perceived competence concepts are theorized to be positive predictors of both self-report and behavioral measures of intrinsic motivation, and pressure/tension is theorized to be a negative predictor of intrinsic motivation. Effort is a separate variable that is relevant to some motivation questions, so is used it its relevant. The value/usefulness subscale is used in internalization studies (e.g., Deci et al, 1994), the idea being that people internalize and become self-regulating with respect to activities that they experience as useful or valuable for themselves.

The IMI items have often been **modified slightly to fit specific activities**. Thus, for example, an item such as "I tried very hard to do well at this activity" can be changed to "I tried very hard to do well on these puzzles" or "...in learning this material" without effecting its reliability or validity. As one can readily tell, there is nothing subtle about these items; they are quite face-valid. However, in part, because of their straightforward nature, caution is needed in interpretation.

Another issue is that of redundancy. Items within the subscales overlap considerably, although randomizing their presentation makes this less salient to most participants. Nonetheless, shorter versions have been used and been found to be quite reliable. Still, it is very important to recognize that multiple item subscales consistently outperform single items for obvious reasons, and they have better external validity.

We recommend a shortened standard version with the four subscales: **interest/enjoyment, perceived competence, perceived choice, and pressure/tension** with 4 items per subscale.

The state emotions survey may deal with following questions:

- Do specific R4C activities influence the students' general motivation?
- Are there gender differences?

2.3.1.3 Situational Emotions in science education (State Emotions, SE)

The Situational Emotions Questionnaire (State Emotions) measures the learning emotions **after** an intervention with three concepts: interest, well-being and boredom. Each subscale has three items and is to be used complete.

The SE may deal with the following questions:

- What emotions have students at R4C activities?
- Are there gender differences?

No reversed items. A higher score will indicate more of the concept described in the subscale name.

2.3.1.4 A scale from 1 (not at all true) to 5 (very true) is used. Cognitive Load

The Cognitive Load rating scale measures students' perceived difficulty. Students have to report the amount of mental effort they invested in the intervention. Therefore, they are asked to estimate their perceived difficulty of the individual items immediately after they had finished an item. The rating scale has to be provided, explained, and illustrated just before the beginning of the R4C implementation. Students take the rating scale during the general instruction with them. After solving a problem or studying a worked-out problem the students had to score the amount of mental effort invested in the preceding problem.

To test the cognitive load without extra tension students must not be graded during the implementation.

The scale has to be individually modified for the project partner's specific intervention. Therefore, a ready to use photo master is not possible. Instead of "Part 1-3" insert the name of your unit, e.g. the name of the station when handling station learning.

The Cognitive Load survey may deal with following questions:

- Do specific R4C activities influence the students' cognitive load?
- Does mental effort influence students' motivation (SMQII)?
- Are there gender differences?

2.3.2 The Questionnaires

2.3.2.1 SMQII

For each of the following statements, please indicate how true it is for you, using the following scale(SMQII):	- -	-	0	+	+ +
Intrinsic Motivation					
Learning science is interesting	☐	☐	☐	☐	☐
I am curious about discoveries in science	☐	☐	☐	☐	☐
The science I learn is relevant to my life	☐	☐	☐	☐	☐
Learning science makes my life more meaningful	☐	☐	☐	☐	☐
I enjoy learning science	☐	☐	☐	☐	☐
Career Motivation					
Learning Science will help me get a good job	☐	☐	☐	☐	☐
Understanding science will benefit me in my career	☐	☐	☐	☐	☐
Knowing science will give me a career advantage	☐	☐	☐	☐	☐
I will use science problem-solving skills in my career	☐	☐	☐	☐	☐
My career will involve science	☐	☐	☐	☐	☐
Self-Determination					
I study hard to learn science	☐	☐	☐	☐	☐
I prepare well for science tests and labs	☐	☐	☐	☐	☐
I put enough effort into learning science	☐	☐	☐	☐	☐
I spend a lot of time learning science	☐	☐	☐	☐	☐
I use strategies to learn science well	☐	☐	☐	☐	☐
Self-efficacy					
I believe I can earn a grade of 'A' in science	☐	☐	☐	☐	☐
I am confident I will do well on science tests	☐	☐	☐	☐	☐
I believe I can master science knowledge and skills	☐	☐	☐	☐	☐
I am sure I can understand science	☐	☐	☐	☐	☐
I am confident I will do well on science labs and projects	☐	☐	☐	☐	☐
Grade Motivation					
Scoring high on science tests and labs matters to me	☐	☐	☐	☐	☐
It is important that I get an "A" in science	☐	☐	☐	☐	☐
I think about the grade I will get in science	☐	☐	☐	☐	☐
Getting a good science grade is important to me	☐	☐	☐	☐	☐
I like do better than other students on science tests	☐	☐	☐	☐	☐

2.3.2.2 IMI

Interest/Enjoyment					
I enjoyed doing this activity very much	☐	☐	☐	☐	☐
This activity was fun to do.	☐	☐	☐	☐	☐
I thought this was a boring activity.	☐	☐	☐	☐	☐
This activity did not hold my attention at all.	☐	☐	☐	☐	☐
I would describe this activity as very interesting.	☐	☐	☐	☐	☐
I thought this activity was quite enjoyable.	☐	☐	☐	☐	☐
While I was doing this activity, I was thinking about how much I enjoyed it.	☐	☐	☐	☐	☐
Perceived Competence					
I think I am pretty good at this activity.	☐	☐	☐	☐	☐
I think I did pretty well at this activity, compared to other students.	☐	☐	☐	☐	☐
After working at this activity for a while, I felt pretty competent.	☐	☐	☐	☐	☐
I am satisfied with my performance at this task.	☐	☐	☐	☐	☐
I was pretty skilled at this activity.	☐	☐	☐	☐	☐
This was an activity that I couldn't do very well.	☐	☐	☐	☐	☐
Pressure/Tension					
I did not feel nervous at all while doing this.	☐	☐	☐	☐	☐
I felt very tense while doing this activity.	☐	☐	☐	☐	☐
I was very relaxed in doing these.	☐	☐	☐	☐	☐
I was anxious while working on this task.	☐	☐	☐	☐	☐
I felt pressured while doing these.	☐	☐	☐	☐	☐
Perceived Choice					
I believe I had some choice about doing this activity.	☐	☐	☐	☐	☐
I felt like it was not my own choice to do this task.	☐	☐	☐	☐	☐
I didn't really have a choice about doing this task.	☐	☐	☐	☐	☐
I felt like I had to do this.	☐	☐	☐	☐	☐
I did this activity because I had no choice.	☐	☐	☐	☐	☐
I did this activity because I wanted to.	☐	☐	☐	☐	☐
I did this activity because I had to.	☐	☐	☐	☐	☐

2.3.2.3 State Emotions

State Emotions	
SE Well-Being 1	The lesson pleased me.
SE Well-Being 2	I was satisfied with the lesson.
SE Well-Being 3	I enjoyed the lesson.
SE Interest 4	I found that topic important.
SE Interest 5	The information on that topic was relevant to me.
SE Interest 6	I want to learn more about that topic.
SE Boredom 7	I felt bored.
SE Boredom 8	(Today) my mind sometimes wandered.
SE Boredom 9	I wanted to sleep through the lesson.

2.3.2.4 Cognitive load

Example for a Cognitive Load Questionnaire Please estimate your perceived difficulty of *[the station (station learning)]* immediately after you finished it. Please do so even when you "gave up" after having tried solving it.	very easy	easy	rather easy	neither - nor	rather difficult	difficult	very difficult
	1	2	3	4	5	6	7
Part 1	☐	☐	☐	☐	☐	☐	☐
Part 2	☐	☐	☐	☐	☐	☐	☐
Part 3	☐	☐	☐	☐	☐	☐	☐
Part 4	☐	☐	☐	☐	☐	☐	☐

2.4 Interviews and Focus Groups

2.4.1 Interviews

When designing an interview schedule, it is imperative to ask questions that are likely to yield as much information about the topic as possible and that will also be able to address the aims and objectives of the research. In a qualitative interview, good questions should be open-ended (require more than a yes/no answer), neutral, sensitive and understandable. Wherever possible, interviews should be conducted in areas free from distractions and at times and locations that are most suitable for participants.

The interview grid consists of a core set of questions designed to elicit more qualitative feedback from participants in the R4C implementation. These interviews should be carried out with teachers and head teachers. The events like summer schools or big events in the Schools or National Events organized by the National Coordinators could be used in order the interviews to be conducted. In the Appendix 6 there are indicative questions to be asked by the person that will conduct the interview could.

About 10% of the attendees of a training event, e.g. summer school, should be asked to be interviewed individually. The interviewer should explain the need of the interview and assure the confidentiality to the interview partners. The duration of the interview will be no more than 20 minutes.

The interview is preferably to be carried through in English. If there are difficulties with the English language the interview has to be carried out through the native tongue and the answers have to be translated into English (at least the main parts in a way of a summary for each part of the interview).

The National Coordinators should take the lead of these interviews in the countries and the Validation Team (Science View) will conduct the interviews in summer schools of the R4C Project (or virtually using skype or zoom).

2.4.2 Focus groups

Focus groups can reveal a wealth of detailed information and insights. When well executed, a focus group creates an accepting environment that puts participants at ease allowing then to thoughtfully answer questions in their own words and add meaning to their answers. Surveys are good for collecting information about people's attributes and attitudes but if you need to understand things at a deeper level then use a focus group. (Eliot & Associates, 2005)

Below, we highlight some general principles to consider:

Standardisation of questions -- Focus groups can vary in the extent to which they follow a structured protocol or permit discussion to emerge.

Number of focus groups conducted - or sampling will depend on the 'segmentation' or different stratifications (e.g. age, sex, socioeconomic status, health status) that the researcher identifies as important to the research topic.

Number of participants per group - the rule of thumb has been 6-10 homogeneous strangers, but as Morgan (1996) points out there may be reasons to have smaller or slightly larger groups.

Level of moderator involvement - can vary from high to low degree of control exercised during focus groups (extent to which structured questions are asked and group dynamics are actively managed).

Defining a focus group

A focus group is a small group of six to ten people led through an open discussion by a skilled moderator. The group needs to be large enough to generate rich discussion but not so large that some participants are left out. The ideal amount of time to set aside for a focus group is anywhere from 45 to 90 minutes. Beyond that most groups are not productive and it becomes an imposition on participant time.

Focus groups are structured around a set of carefully predetermined questions – usually no more than 10 – but the discussion is free-flowing. Ideally, participant comments will stimulate and influence the thinking and sharing of others. Some people even find themselves changing their thoughts and opinions during the group. It takes more than one focus group on any one topic to produce valid results – usually three or four. You'll know you've conducted enough groups (with the same set of questions) when you're not hearing anything new anymore, i.e. you've reached a point of saturation.

Designing focus group questions

Focus group participants will not have the opportunity to see the questions they are being asked. To ensure that they understand and can fully respond to the questions, questions should be:

- Short and to the point
- Focused on one dimension each
- Unambiguously worded
- Open-ended or sentence completion types
- Non-threatening or embarrassing
- Worded in a way that they cannot be answered with a simple "yes" or "no" answer (use "why" and "how" instead)

There are three types of focus group questions:

- Engagement questions: introduce participants to and make them comfortable with the topic of discussion
- Exploration questions: get to the meat of the discussion
- Exit question: check to see if anything was missed in the discussion

Once a group of viable recruits has been established, call each one to confirm interest and availability. Give them times and locations of the focus groups and secure verbal confirmation. Tell them you will mail (or email) them a written confirmation and call to remind them two days before the scheduled group.

Organize the times, locations and people involved for all the groups you have scheduled.

Reduce barriers to attending when possible by offering:

- Evening or weekend groups for those who work during the day
- Transportation or cab fare
- Interpreter services
- A familiar public setting

Inform participants that the focus group will take about one and half to two hours. Provide a starting time that is 15 minutes prior to the actual start of the focus group to allow for filling out necessary paperwork and settling into the group.

Arrange for a comfortable room in a convenient location with ample parking. Depending on your group, you may also what to consider proximity to a bus line. The room should have a door for privacy and table and chairs to seat a circle of up to 12 people (10 participants and the moderator and assistant moderator). Many public agencies (churches, libraries) have free rooms available.

Ideally, the focus group is conducted by a team consisting of a moderator and assistant moderator. The moderator facilitates the discussion; the assistant takes notes and runs the tape recorder.

The ideal focus group moderator has the following traits:

- Can listen attentively with sensitivity and empathy
- Is able to listen and think at the same time
- Believes that all group participants have something to offer no matter what their education, experience, or background
- Has adequate knowledge of the topic
- Can keep personal views out of the facilitation
- Is someone the group can relate to but also give authority to

- Can appropriately manage challenging group dynamics

The assistant moderator must be able to do the following:

1. Run a tape recorder during the session
2. Take notes in case the recorder fails or the tape is inaudible
3. Note/record body language or other subtle but relevant clues
4. Allow the moderator to do all the talking during the group
5. Both moderator and assistant moderator are expected to welcome participants, offer them food, help them make their name tents, and direct them in completing pre-group paperwork.

At a minimum, all participants should complete a consent form. If the focus group study involves a university partner or is part of a larger research study you may also be required to secure approval from a Human Subjects Committee.

It may be important to collect demographic information from participants if age, gender, or other attributes are important for correlation with focus group findings. Design a short half page form that requires no more than two or three minutes to complete. Administer it before the focus group begins.

Once consent forms and demographic surveys are collected and reviewed for completeness, the discussion begins. The moderator uses a prepared script to welcome participants, remind them of the purpose of the group and set ground rules.

Before asking the first focus group question, an icebreaker can be inserted to increase comfort.

The focus group moderator has a responsibility to adequately cover all prepared questions within the time allotted. S/he also has a responsibility to get all participants to talk and fully explain their answers. It is good moderator practice to paraphrase and summarize long, complex or ambiguous comments. It demonstrates active listening and clarifies the comment for everyone in the group.

In order for all participant comments to be understandable and useful, they must be condensed into essential information using a systematic and verifiable process. Begin by transcribing all focus group tapes and inserting notes into transcribed material where appropriate.

Indicative Questions:

- The R4C School Innovation Model offers certain approaches and features, do these respond to your needs as a teacher?
- What are the most interesting and relevant aspect of the R4C proposed approaches?
- What are the main innovative elements?
- Is the R4C and OSOS portal useful to your day to day work? Is it there a collaborative environment that you can work with?
- Which parts of the R4C Approaches need improvement?
- Do your school provide all the needed support for your professional development?
- Do you feel free to propose new ideas in your school and to implement them within your classroom?
- Do you collaborate with parent and external stakeholders?

2.5 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 R4C as well as the OSOS platform (that the schools will use in order to create communities and projects during the implementation phase of the project) 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.

2.5.1 Users Behaviour

The data that will 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 used to track users' behaviors (e.g. the users' loyalty of an educational Portal (portal.discoverthecosmos.eu), see Figure 5) including referring methods, search terms, technology use, page paths (number of visits, time spend on site), entry/exit pages, and geo-segmentation.

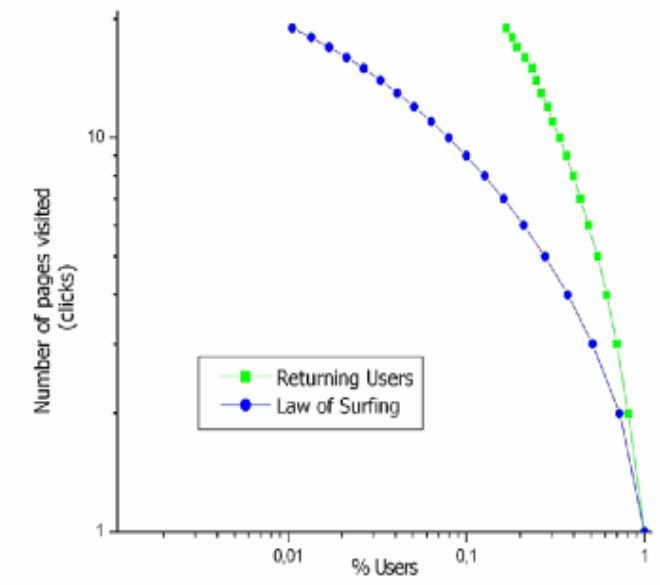


Figure 5: ***Users Behavior****: Returning COSMOS Repository users show high levels of loyalty stay longer on site, make more page views. They are benchmarked against the law of surfing (Huberman et al. 1998) and outperform it. About 15% of the COSMOS Portal users are visiting more than 20 pages per 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).*

2.5.2 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 6). The data are from the use of the OpenScienceResources Portal that supports the development of educational pathways between formal and informal settings.

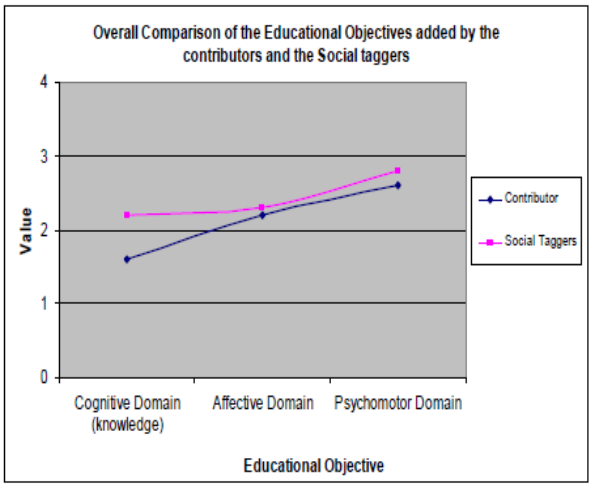


Figure 6: *Benchmarking the educational value of eLearning resources: The OpenScienceResources consortium (www.osrportal.eu) has developed a classification system for the characterization of the educational objectives (based on Blooms Taxonomy) of the proposed activities and the users are capable to 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.*

2.5.3 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 R4C 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 7 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 ($p < 0.05$).

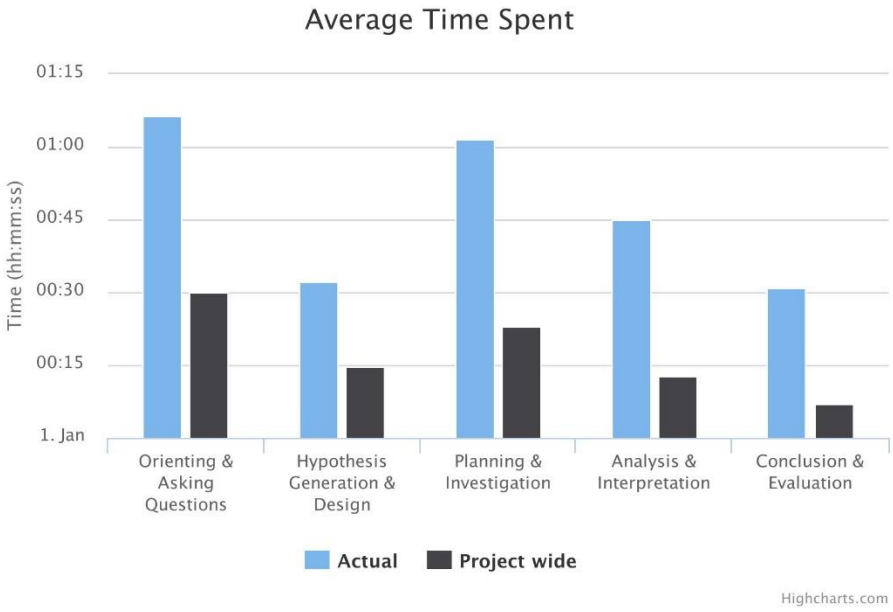


Figure 7: *The average time spent per phase in "Light: Reflection and Refraction" lesson compared to the overall average time per phase. The data indicate that this is a time consuming and (maybe) a rather complex task for students.*

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 8). 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 9). 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 8: *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, analyze 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.

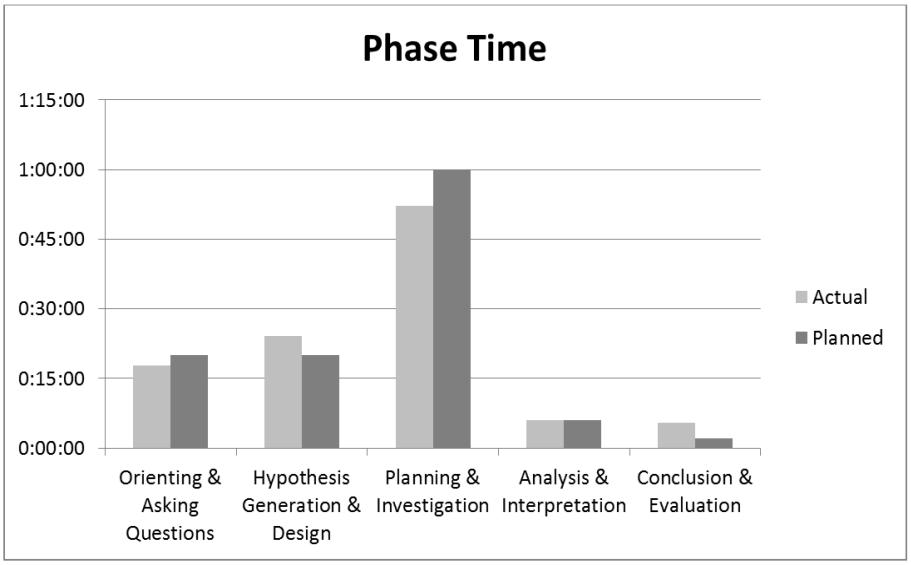


Figure 9: *The average time spent per phase in "Looking for Higgs Boson" lesson (with the use of the HYPATIA virtual lab in phase 3) compared to the planned/proposed time per phase. The data indicate that the implementations were made according to the proposed inquiry approach.*

2.5.4 Class Profile

In this section, we are discussing the Class-Profile metric. Students are categorised in three categories according to PISA 2014 (see **Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**). 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 11 for all the inquiry phases and for all lessons in all countries (about 11,000 students' data sets from about 600 lesson implementations).

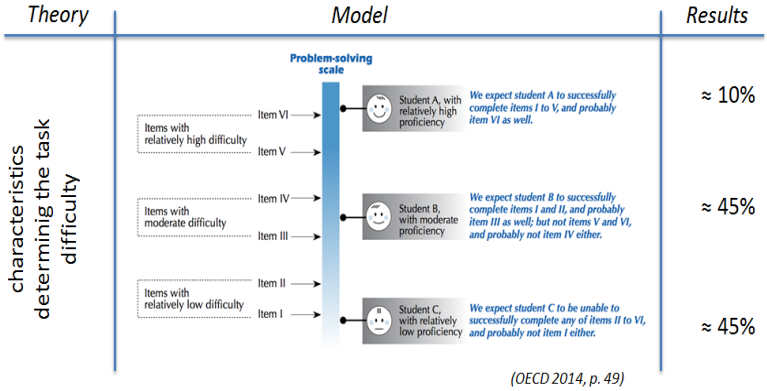


Figure 10: *Students categorisation according to PISA 2014 as far as their levels of proficiency in dealing with tasks of varying difficulty. On average OECD countries classrooms consist of 45% of students who show low proficiency, 45% with students with moderate proficiency and only 10% with students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

Figure 11: *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.

2.5.5 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 refering again to the same sample (11,000 students) and they are presented as the percentage of the total number of replies.

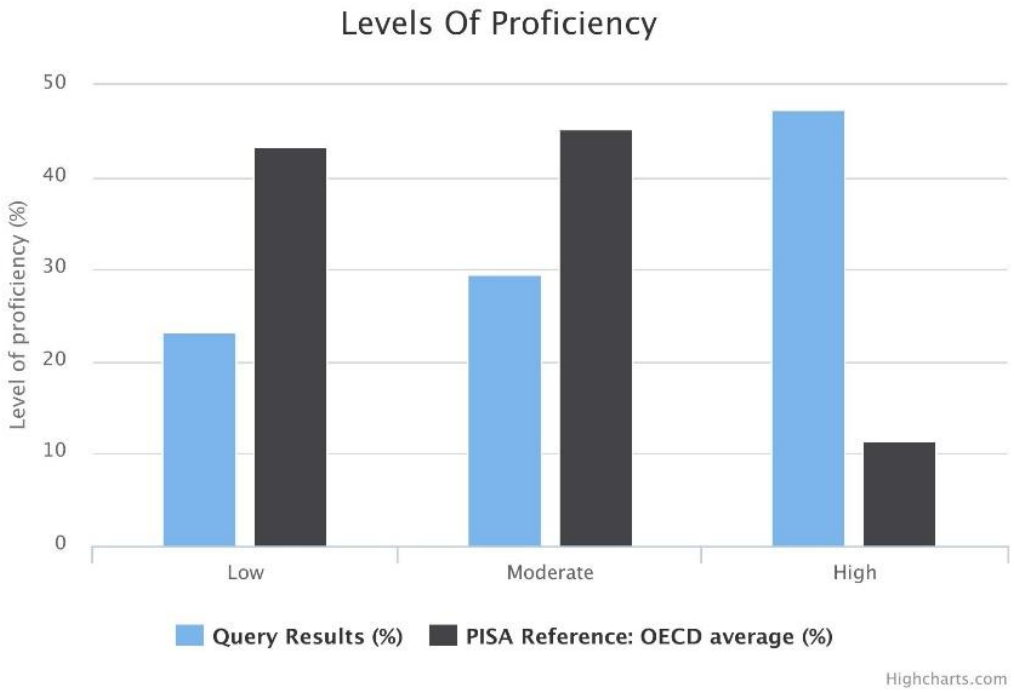


Figure 12: *The frequency of high, moderate and low levels of proficiency (%).*

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 12 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.

3 Conclusions

This deliverable presents the tools that will be used during the R4C Implementation in order to collect the needed feedback (data) and analyse them. Tools that are presented are following the Validation Methodology and Plan (D4.1) and aim to measure the impact of the School Innovation Model (D1.1).

To measure the proposed transformations of the school unit the R4C validation 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. The main tools presented, are Questionnaires that will be used in different situations. The most important instrument is the R4C Self-Reflection tool. This will be the main tool to measure the organisational change (Innovation, Openness and e-maturity) and the RRI integration in the schools and has structured in way to give the opportunity to each school to identify the status and the level of innovation according to the R4C School Innovation Model. The students of the participating schools will have also to fill in questionnaires according to the activities (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 R4C Implementation Plan. Finally, there are going to be used the data from the web analytics, data that the R4C and 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

During the Implementation phase with the 300 R4C Schools the tools will be tested and possible modifications and updated will be realized by the end of the project in order to recommend a well-tested and reliable tool.

All the tools that are presented in the current deliverable will be able to be translated in all the partners countries' languages. For this the National Coordinators will be responsible and decide the need for this.

4 References

Bandura, A. (1986). Social foundations of thought and action: A social cognitive Theory. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. Child Development, 72, 187-206. doi: 10.1111/1467- 8624.00273

Bellebaum, A. (1990). Langeweile, Überdruß und Lebenssinn. Opladen: Westdeutscher Verlag.

Black, A. E., & Deci, E. L. (2000). The effects of instructors' autonomy support and students' autonomous motivation on learning organic chemistry: A self-determination theory perspective. Science Education, 84(6), 740–756.

Bryan, R. R., Glynn, S. M., & Kittleson, J. M. (2011). Motivation, achievement, and advanced placement intent of high school students learning science. Science Education, 95(6), 1049–1065.

Bybee, R.W. (1997). Achieving Scientific Literary: From Purposes to Practices. Portsmouth, NH: Heinemann.

Bybee, R.W. (2000). Teaching science as inquiry. In van Zee, E.H. (Ed.), Inquiring into Inquiry Learning and Teaching Science. Washington, DC: AAAS. pp 20–46.

Bybee, R.W., Powell, J.C & Trowbridge, L.W. (2008). Teaching Secondary School Science: Strategies for Developing Scientific Literacy. Upper Saddle River, NJ: Pearson Education (9th Edition).

Chiappetta, E.L. (1997). Inquiry-based Science: Strategies and Techniques for Encouraging Inquiry in the Classroom. The Science Teacher, 64(10), pp 22-26.

Csikszentmihalyi, M. & LeFevre, J. (1987). The experience of work and leisure. Journal of Personality and Social Psychology, 56, 815-822.

Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York, NY: Plenum.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. Psychological Bulletin, 125(6), 627–668.

Furnham, A., & Chamorro-Premuzic, T. (2004). Personality and intelligence as predictors of statistics examination grades. Personality and Individual Differences, 37(5), 943–955.

Gläser-Zikuda, M., Fuß, S., Laukenmann, M., Metz, K. & Randler, C. (2005). Promoting stu-dents_ emotions and achievement – conception and evaluation of the ECOLE approach. Learning and Instruction, 15, 481-495.

Gläser-Zikuda, M. & Fuß, S. (2008). Impact of teacher competencies on students' emotion - a multi-method approach. International Journal of Educational Research, 47, 136-147.

Glynn, S. M., & Koballa Jr., T. R. (2006). Motivation to learn in college science. In J. J. Mintzes & W.H. Leonard (Hg.), Handbook of college science teaching (pp. 25–32). Arlington, VA: NSTA Press.

Glynn, S. M., Taasoobshirazi, G., & Brickman, P. (2009). Science motivation questionnaire: Construct validation with nonscience majors. Journal of Research in Science Teaching, 46(2), 127–146.

Glynn, S. M., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011). Science motivation questionnaire-II: Validation with science majors and nonscience majors. Journal of Research in Science Teaching, 48(10), 1159–1176

Harlen, W. (Ed) (2010). Principles and Big Ideas of Science Education. Hatfield: ASE.

Hidi, S., Renninger, K.-A. & Krapp, A. (1992). The role of interest in learning and development. Hillsdale: Erlbaum.

Hounsell, D. & McCune, V. (2003). 'Students' experiences of learning to present'. In: C. Rust, C. (ed.) Improving Student Learning Theory and Practice – Ten Years On. Proceedings of the Tenth International Symposium on Improving Student Learning, Brussels, September 2002. Oxford: CSLD. pp. 109-118.

Kampylis, K, Punie Y, Devine J. 2015. Promoting effective digital-age learning. A European Framework for Digitally-Competent Educational Organisations

Kelly, U. and McNicoll, I. 2011 Through a glass, darkly: Measuring the social value of universities Bristol, UK: NCPE

Krystyniak, R., A & Heikkinen, H.W. (2007). Analysis of Verbal Interactions During an Extended Open-Inquiry General Chemistry Laboratory Investigation. Journal of Research in Science Teaching, 44(8), pp 1160-1186.

Linn, M.C., Davis E.A. & Bell, P.L. (2004) Inquiry and Technology. In M.C. Linn, E.A. Davis & P.L. Bell (Eds.), Internet environments for science education. Mahwah, NJ: Lawrence Erlbaum Associates. pp 3-27.

Lovelace, M., & Brickman, P. (2013). Best practices for measuring students' attitudes toward learning science. Cell Biology Education, 12(4), 606–617.

Mayring, P. (2009). Freude und Glück. In V. Brandstätter & J.H. Otto (Hrsg.), Handbuch der Allgemeinen Psychologie – Motivation und Emotion (pp. 585 – 595). Göttingen Hogrefe.

Minner, D.D., Levy, A.J. & Century, J. (2010). Inquiry-based science instruction—what is it and does it matter? Results from a research synthesis years 1984 to 2002. Journal of Research in Science Teaching, 47, pp 474–496.

National Research Council (NRC) (1996). The National Science Education Standards. Washington, D.C.: National Academy Press.

National Research Council (2000). Inquiry and the National Science Education Standards: A guide for teaching and learning. Washington D.C.: The National Research Council.

OECD (2013). PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy. Paris: OECD Publishing.

http://dx.doi.org/10.1787/9789264190511-en

OECD (2014). PISA 2012 Results: Creative Problem Solving: Students' Skills in Tackling Real-Life Problems (Volume V). Paris: OECD Publishing.http://dx.doi.org/10.1787/9789264208070-en

Pajares, F. (1996). Self-efficacy beliefs and mathematical problem-solving of gifted students. Contemporary Educational Psychology, 21(4), 325–344.

Pajares, F. (2002). Gender and perceived self-efficacy in self-regulated learning. Theory into Practice, 41(2), 116–125.

Palmer, D. H. (2009). Student interest generated during an inquiry skills lesson. Journal of Re-search in Science Teaching, 46, 147–165.

Randler, C; Hummel, E; Gläser-Zikuda, M; Vollmer, C; Bogner, FX; Mayring, P: Reliability and validation of a short scale to measure situational emotions in science education, International Journal of Environmental & Science Education, 6(4), 359-370 (2011)

Rothstein, M. G., Paunonen, S. V., Rush, J. C., & King, G. A. (1994). Personality and cognitive ability predictors of performance in graduate business school. Journal of Educational Psychology, 86(4), 516–530.

Rocard, M., Csermely, P., Jorde, D., Lenzen, D., Walberg-Henriksson, H. & Hemm, V. (2007). Science Education Now: A Renewed Pedagogy for the Future of Europe. Brussels: Directorate General for Research, Science, Economy and Society.

Rummler, G.A., Brache A.P. (1995). Improving Performance. Jossey-Bass Publishers.

Tamir, P. (1985). Content analysis focusing on inquiry. Journal of Curriculum Studies, 17(1), pp 87-94.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54–67.

SELFIE (2017)[Online] Available from: https://ec.europa.eu/jrc/en/digcomporg/selfie-tool [Accessed 30 March 2020]

Schumm, M; Bogner, FX (2016): Measuring adolescent science motivation, International Journal of Science Education, 38(3), 434-449 (2016), doi:10.1080/09500693.2016.1147659

Schunk, D. H., Pintrich, P. R., & Meece, J. L. (2008). Motivation in education. Theory, research, and applications. Upper Saddle River, NJ: Pearson/Merrill Prentice Hall.

Schwab, J.J. (1962). The teaching of science as inquiry. In Brandwein, P.F. (Ed.), The Teaching of Science. Cambridge: Harvard University Press.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. The Journal of Educational Research, 95(6), 323–332.

Sotiriou, M., Mordan, C., Murphy, P., Lovatt, J., Sotiriou, S., Bogner, F., (2017) OSOS Assessment Methodology, D6.1

Sotiriou, M., Koukovinis A., Mordan C., Murphy P., Lovatt J., Sotiriou S., Giannakopoulou A., Bogner F. (2018). OSOS Assessment Tools - D6.2

Sotiriou, M., Triantafyllou G., Chadwick, R., McLoughlin, E., Murphy. P., Bogner, F., Marth, M., Sotiriou S., Zygouritsas, N., (2020). OSOS Final Impact Assessment Report - D6.4

Sotiriou, M., Triantafyllou G., Sotiriou, S., Bogner, F., (2020) R4C Validation Methodology and Plan, D4.1

Sotiriou, S., & Bogner, F. X. (2011). Inspiring Science Learning: Designing the Science Classroom of the Future. Advanced Science Letters, 4(11-12), pp. 3304-3309.

Sotiriou, S., Bogner, F., and Neofotistos, G., Quantitative Analysis of the Usage of the COSMOS Science Educational Portal, Journal of Science Education and Technology (2011) 20:333-346 DOI 10.1007/s10956-010-9256-1

Sotiriou, S., Riviou, K., Cherouvis, S., Chelioti, E., & Bogner, F.X. (2016). Introducing Large-Scale Innovation in Schools. Journal of Science Education and Technology, pp. 1-9.

Spielberger, C. D., Gorsuch, R. L. & Lushene, R.E. (1970). State-Trait Anxiety Inventory, Ma-nual for the State-Trait Anxiety Inventory; Palo Alto, CA: Consulting Psychologist Press.

Strack, F., Argyle, M. & Schwarz, N. (Eds.). (1990). Subjective well-being. Oxford: Pergamon.

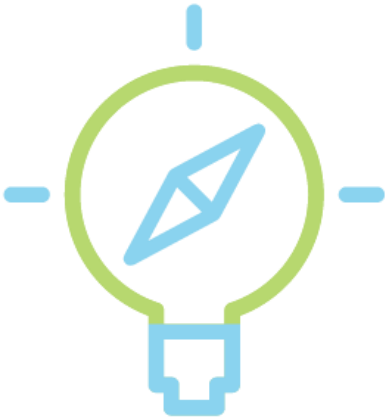
Ulich, D., & Mayring, P. (1992). Psychologie der Emotionen (Psychology of emotions). Stuttgart, Kohlhammer.

Zion, M, Slezak, M, Shapira, D, Link, E, Bashan, N, Brumer, M, Orian, T, Nussinowitz, R, Court, D, Agrest, B, Mendelovici, R, Valanides, N, . (2004). Dynamic, Open Inquiry in Biology Learning. Science Education, 88(5), pp 728-753.

Zeyer, A. T., Çetin-Dindar, A., Md Zain, A. N., Juriševič, M., Devetak, I., & Odermatt, F. (2013). Systemizing: A cross-cultural constant for motivation to learn science. Journal of Research in Science Teaching, 50(9), 1047–1067.

5 Appendixes

5.1 Appendix 1: School Development Plan Template



R4C

Reflecting for Change

School Development Plan

xx/xx/xxxx

NAME OF THE SCHOOL

Co-funded by the Erasmus+ Programme of the European Union

This project has received funding from the European Union's ERASMUS+ Programme under grant agreement No. 612879-EEP-1-2019-1-EL-EPPKA3-PI-FORWARD

1. School details
Name of School: …… …… School website/email: …… …… Address: …… …… How many students does the school have? …… …… How many teachers does the school have? …… …… How many teachers will be involved in R4C activities? …… …… Names of teachers participating in R4C: …… …… E-mail addresses of teachers participating in R4C: …… …… Name of teacher who facilitates the team: …… …… E-mail address of teacher who facilitates the team: …… …… Name of school principal: …… …… How many students will be involved in R4C activities? …… …… Ages of participating students: …… ……

2. Insight – Where are we now

Where do you think your school stands regarding the following school characteristics on innovation? Please have in mind also the Self Reflection Tool that you have filled in.

The school as an evolving learning ecosystem

1. Does your school set up broad and inclusive consultation processes, to build trust and enhance support for changes?
2. Does your school consider regional or local partnerships to stimulate school development or support the implementation of specific changes?
3. Does your school create opportunities to take on additional roles to classroom teaching, at school (coordinating roles; support to colleagues, including mentoring, professional development, involvement in school development, (international) project work, extracurricular activities, co-operation with external partners)?
4. Does your school create partnerships between schools and higher education institutions, focused on research, creating collaboration between theory and practice (involving both teacher education providers and faculties of educational science);
5. Does your school promote gender equality (teacher addressing classroom dynamics, teacher debunking students' stereotypes)?
6. Does your school effectively engage parents?

How do you plan to address these issues through your participation in the R4C activities?

……

……

……

……

……

……

……

……

……

……

Teachers as professionals, professional development and collaboration
1. Does your school encourage and support collaboration among staff for teaching (e.g. team teaching; sharing of teaching resources) and staff learning? 2. Does your school consider cross-school networks and digital platforms to support (a culture of) collaboration in the teaching profession? 3. Does your school support a culture of collaboration by avoiding situations that could encourage counterproductive competition between individuals? Encourage links between schools and providers of teacher education; 4. Does your school support Continuing Professional Development for school staff, with a preference for a broad, open and inclusive concept that is operational at the same time (including formal, informal and non-formal forms of professional learning)? 5. Does your school consider making CPD an obligation/explicit duty, and allocating working time to it? 6. Does your school create opportunities for/encourage/support school staff to engage in school-to-school networks to share expertise and teaching resources, spread innovation or support school development? How do you plan to address these issues through your participation in the R4C activities? …… …… …… …… …… …… …… …… …… ……

Does the concept of school innovation and openness resonate in the practices described above?
…… …… …… …… ……

Does the national educational system and its regulations allow autonomy to your school to develop as a learning organization?
…… …… …… …… ……

3. Vision – Where do we want to go

How do you expect the school characteristics, regarding a School Innovation Culture, will change through your participation in R4C?

Collaboration with non-formal and informal education providers, enterprises and civil society enhanced
…… …… …… …… ……

Schools as agents of community well-being
…… …… …… …… ……

Partnerships that foster expertise, networking, sharing and applying science and technology research findings and that bringing real-life projects to the classroom
…… …… …… …… ……

Effective Parental Engagement
…… …… …… …… ……

Teaching science for difference: Gender Issues
…… …… …… …… ……

How might you explore these ideas further and develop your school as a learning organisation?
…… …… …… …… ……

How do you expect to apply the four P's characteristics in your activities through your participation in R4C?

Placed: The activity is located, either physically or virtually, in a world that the student recognizes and is seeking to understand.
…… …… …… …… ……

Purposeful: The activity feels authentic, it absorbs the student in actions of practical and intellectual value and fosters a sense of agency.
…… …… …… ……

……

Passion-led: The activity enlists the outside passions of both students and teachers, enhancing engagement by encouraging students to choose areas of interest which matter to them.
……
……
……
……
……

Pervasive: The activity enables the student to continue learning outside the classroom, drawing on family members, peers, local experts, and online references as sources of research and critique
……
……
……
……
……

According to the Self Reflection report your school is in a specific status and there were recommended specific strategies and activities to follow. Which activities (though the OSOS accelerators) are you going to use? Why did you choose it? How are you going to adapt it to the needs of your school?

……
……
……
……
……

5.2 Appendix 2: SMQ PRE QUESTIONNAIRE

PRE-TEST (T0)

Dear students,

Thank you for your participation!

All questionnaires are part of a study and your answers are strictly confidential! Your teacher will neither evaluate nor mark it!

- Work accurately on the tests on your own!
- Use pen, not pencil!
- Marc with a cross the answers that are right to your own opinion!
- Please answer all questions!
- When you want to change an answer, color the "wrong" check box and marc another.
- Do not speak about third parties. Answer according to your own opinion.
- Do not worry – some questions might be difficult. This is common.
- When you are ready – please check all pages. Have you finished everything?

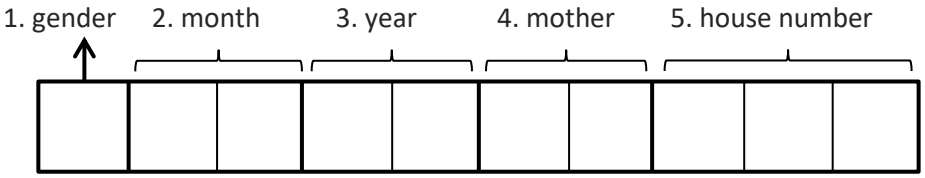
Your School _____. **Your class** _____

Date of today ____ . ____ . _____

Your personal Code:

Your personal Code is built up of:

1. your **gender**: girl is female (**F**) or boy is male (**M**)
2. your **month** of birth (01, 02, 03, …, 10, 11, 12)
3. your **year** of birth (e.g. 98, 99, 00, 01)
4. the **two first letters** of your **mother's first name** (e.g. AN for Anna)
5. your **house number** (e.g. 001 for house number 1; 016 for house number 16)



Example: *Daniel is a boy, i.e. male, born in august 2000; his mother's name is Sandra and he lives in house number 12. Daniel's code is:*

m	0	8	0	0	S	A	0	1	2

In order to better understand what you think and how you feel about your college science courses, please respond to each of the following statements.

For each of the following statements, please indicate how true it is for you, using the following scale(SMQII):	**- -**	**-**	**0**	**+**	**+ +**
Learning science is interesting	☐	☐	☐	☐	☐
I am curious about discoveries in science	☐	☐	☐	☐	☐
The science I learn is relevant to my life	☐	☐	☐	☐	☐
Learning science makes my life more meaningful	☐	☐	☐	☐	☐
I enjoy learning science	☐	☐	☐	☐	☐
Learning Science will help me get a good job	☐	☐	☐	☐	☐
Understanding science will benefit me in my career	☐	☐	☐	☐	☐
Knowing science will give me a career advantage	☐	☐	☐	☐	☐
I will use science problem-solving skills in my career	☐	☐	☐	☐	☐
My career will involve science	☐	☐	☐	☐	☐
I study hard to learn science	☐	☐	☐	☐	☐
I prepare well for science tests and labs	☐	☐	☐	☐	☐
I put enough effort into learning science	☐	☐	☐	☐	☐
I spend a lot of time learning science	☐	☐	☐	☐	☐
I use strategies to learn science well	☐	☐	☐	☐	☐
I believe I can earn a grade of ‘A’ in science	☐	☐	☐	☐	☐
I am confident I will do well on science tests	☐	☐	☐	☐	☐
I believe I can master science knowledge and skills	☐	☐	☐	☐	☐
I am sure I can understand science	☐	☐	☐	☐	☐
I am confident I will do well on science labs and projects	☐	☐	☐	☐	☐
Scoring high on science tests and labs matters to me	☐	☐	☐	☐	☐
It is important that I get an “A” in science	☐	☐	☐	☐	☐
I think about the grade I will get in science	☐	☐	☐	☐	☐
Getting a good science grade is important to me	☐	☐	☐	☐	☐
I like do better than other students on science tests	☐	☐	☐	☐	☐

	consensus				
For each of the following statements, please indicate how true it is for you, using the following scale(IMI):	**- -**	**-**	**0**	**+**	**++**
I enjoyed doing this activity very much	☐	☐	☐	☐	☐
This activity was fun to do.	☐	☐	☐	☐	☐
I thought this was a boring activity.	☐	☐	☐	☐	☐
This activity did not hold my attention at all.	☐	☐	☐	☐	☐
I would describe this activity as very interesting.	☐	☐	☐	☐	☐
I thought this activity was quite enjoyable.	☐	☐	☐	☐	☐
While I was doing this activity, I was thinking about how much I enjoyed it.	☐	☐	☐	☐	☐
I think I am pretty good at this activity.	☐	☐	☐	☐	☐
I think I did pretty well at this activity, compared to other students.	☐	☐	☐	☐	☐
After working at this activity for a while, I felt pretty competent.	☐	☐	☐	☐	☐
I am satisfied with my performance at this task.	☐	☐	☐	☐	☐
I was pretty skilled at this activity.	☐	☐	☐	☐	☐
This was an activity that I couldn't do very well.	☐	☐	☐	☐	☐
I did not feel nervous at all while doing this.	☐	☐	☐	☐	☐
I felt very tense while doing this activity.	☐	☐	☐	☐	☐
I was very relaxed in doing these.	☐	☐	☐	☐	☐
I was anxious while working on this task.	☐	☐	☐	☐	☐
I felt pressured while doing these.	☐	☐	☐	☐	☐
I believe I had some choice about doing this activity.	☐	☐	☐	☐	☐
I felt like it was not my own choice to do this task.	☐	☐	☐	☐	☐
I didn't really have a choice about doing this task.	☐	☐	☐	☐	☐
I felt like I had to do this.	☐	☐	☐	☐	☐
I did this activity because I had no choice.	☐	☐	☐	☐	☐
I did this activity because I wanted to.	☐	☐	☐	☐	☐
I did this activity because I had to.	☐	☐	☐	☐	☐

5.3 Appendix 3: SMQ POST QUESTIONNAIRE

POST-TEST (T1)

Dear students,

Thank you for your participation!

All questionnaires are part of a study and your answers are strictly confidential! Your teacher will neither evaluate nor mark it!

- Work accurately on the tests on your own!
- Use pen, not pencil!
- Marc with a cross the answers that are right to your own opinion!
- Please answer all questions!
- When you want to change an answer, color the "wrong" check box and marc another.
- Do not speak about third parties. Answer according to your own opinion.
- Do not worry – some questions might be difficult. This is common.
- When you are ready – please check all pages. Have you finished everything?

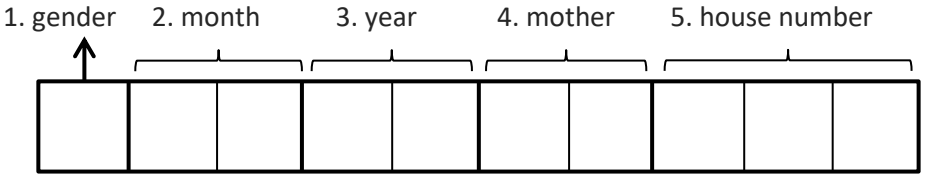
Your School _____. **Your class** _____

Date of today ____ . ____ . _____

Your personal Code:

Your personal Code is built up of:

6. your **gender**: girl is female (**F**) or boy is male (**M**)
7. your **month** of birth (01, 02, 03, …, 10, 11, 12)
8. your **year** of birth (e.g. 98, 99, 00, 01)
9. the **two first letters** of your **mother's first name** (e.g. AN for Anna)
10. your **house number** (e.g. 001 for house number 1; 016 for house number 16)



Example: *Daniel is a boy, i.e. male, born in august 2000; his mother's name is Sandra and he lives in house number 12. Daniel's code is:*

m	0	8	0	0	S	A	0	1	2

In order to better understand what you think and how you feel about your college science courses, please respond to each of the following statements.

For each of the following statements, please indicate how true it is for you, using the following scale(SMQII):	**- -**	**-**	**0**	**+**	**+ +**
Learning science is interesting	☐	☐	☐	☐	☐
I am curious about discoveries in science	☐	☐	☐	☐	☐
The science I learn is relevant to my life	☐	☐	☐	☐	☐
Learning science makes my life more meaningful	☐	☐	☐	☐	☐
I enjoy learning science	☐	☐	☐	☐	☐
Learning Science will help me get a good job	☐	☐	☐	☐	☐
Understanding science will benefit me in my career	☐	☐	☐	☐	☐
Knowing science will give me a career advantage	☐	☐	☐	☐	☐
I will use science problem-solving skills in my career	☐	☐	☐	☐	☐
My career will involve science	☐	☐	☐	☐	☐
I study hard to learn science	☐	☐	☐	☐	☐
I prepare well for science tests and labs	☐	☐	☐	☐	☐
I put enough effort into learning science	☐	☐	☐	☐	☐
I spend a lot of time learning science	☐	☐	☐	☐	☐
I use strategies to learn science well	☐	☐	☐	☐	☐
I believe I can earn a grade of ‘A’ in science	☐	☐	☐	☐	☐
I am confident I will do well on science tests	☐	☐	☐	☐	☐
I believe I can master science knowledge and skills	☐	☐	☐	☐	☐
I am sure I can understand science	☐	☐	☐	☐	☐
I am confident I will do well on science labs and projects	☐	☐	☐	☐	☐
Scoring high on science tests and labs matters to me	☐	☐	☐	☐	☐
It is important that I get an “A” in science	☐	☐	☐	☐	☐
I think about the grade I will get in science	☐	☐	☐	☐	☐
Getting a good science grade is important to me	☐	☐	☐	☐	☐
I like do better than other students on science tests	☐	☐	☐	☐	☐

	consensus				
For each of the following statements, please indicate how true it is for you, using the following scale(Emotions):	**- -**	**-**	**0**	**+**	**++**
The lesson pleased me.	☐	☐	☐	☐	☐
I was satisfied with the lesson.	☐	☐	☐	☐	☐
I enjoyed the lesson.	☐	☐	☐	☐	☐
I found that topic important.	☐	☐	☐	☐	☐
The information on that topic was relevant to me.	☐	☐	☐	☐	☐
I want to learn more about that topic.	☐	☐	☐	☐	☐
I felt bored.	☐	☐	☐	☐	☐
(Today) my mind sometimes wandered.	☐	☐	☐	☐	☐
I wanted to sleep through the lesson.	☐	☐	☐	☐	☐

5.4 Appendix 4: IMI QUESTIONNAIRE

	consensus				
For each of the following statements, please indicate how true it is for you, using the following scale(IMI):	**- -**	**-**	**0**	**+**	**++**
I enjoyed doing this activity very much	☐	☐	☐	☐	☐
This activity was fun to do.	☐	☐	☐	☐	☐
I thought this was a boring activity.	☐	☐	☐	☐	☐
This activity did not hold my attention at all.	☐	☐	☐	☐	☐
I would describe this activity as very interesting.	☐	☐	☐	☐	☐
I thought this activity was quite enjoyable.	☐	☐	☐	☐	☐
While I was doing this activity, I was thinking about how much I enjoyed it.	☐	☐	☐	☐	☐
I think I am pretty good at this activity.	☐	☐	☐	☐	☐
I think I did pretty well at this activity, compared to other students.	☐	☐	☐	☐	☐
After working at this activity for a while, I felt pretty competent.	☐	☐	☐	☐	☐
I am satisfied with my performance at this task.	☐	☐	☐	☐	☐
I was pretty skilled at this activity.	☐	☐	☐	☐	☐
This was an activity that I couldn't do very well.	☐	☐	☐	☐	☐
I did not feel nervous at all while doing this.	☐	☐	☐	☐	☐
I felt very tense while doing this activity.	☐	☐	☐	☐	☐
I was very relaxed in doing these.	☐	☐	☐	☐	☐
I was anxious while working on this task.	☐	☐	☐	☐	☐
I felt pressured while doing these.	☐	☐	☐	☐	☐
I believe I had some choice about doing this activity.	☐	☐	☐	☐	☐
I felt like it was not my own choice to do this task.	☐	☐	☐	☐	☐
I didn't really have a choice about doing this task.	☐	☐	☐	☐	☐
I felt like I had to do this.	☐	☐	☐	☐	☐
I did this activity because I had no choice.	☐	☐	☐	☐	☐
I did this activity because I wanted to.	☐	☐	☐	☐	☐
I did this activity because I had to.	☐	☐	☐	☐	☐

5.5 Appendix 5: Cognitive Load QUESTIONNAIRE

Cognitive load:

Please estimate your perceived difficulty of *[the station (station learning)]* immediately after you finished it. Please do so even when you "gave up" after having tried solving it.	very easy 1	easy 2	neither - nor 3	difficult 4	very difficult 5
Part 1	☐	☐	☐	☐	☐
Part 2	☐	☐	☐	☐	☐
Part 3	☐	☐	☐	☐	☐

Note Please insert your implementation parts.

5.6 Appendix 6: EXTENDED Interview form

When designing an interview schedule, it is imperative to ask questions that are likely to yield as much information about the topic as possible and that will also be able to address the aims and objectives of the research. In a qualitative interview, good questions should be open-ended (require more than a yes/no answer), neutral, sensitive and understandable. Wherever possible, interviews should be conducted in areas free from distractions and at times and locations that are most suitable for participants.

General questions about RRI

What does responsible research mean to you?	
How would you define RRI in your context?	
What is the role of science in society?	
What should be implemented and what not?	
How do you support RRI?	

Questions for the School approaches

The R4C Innovation Model offers certain approaches and features, do these respond to your needs as a teacher?	
What are the most interesting and relevant aspect of the R4C proposed approaches?	
What are the main innovative elements?	
Is the R4C and OSOS portal useful to your day to day work? Is it there a collaborative environment that you can work with?	
Which parts of the R4C Approaches need improvement?	
Do your school provide all the needed support for your professional development?	
Do you feel free to propose new ideas in your school and to implement them within your classroom?	
Do you collaborate with parent and external stakeholders?	

Development questions

What barriers are there to integrate R4C approaches at your school?	
How open is the school to critical scrutiny	
Is there ability to change after internal reflective practice and external feedback?	
What is needed at your school for raising its innovation, openness and e-maturity levels?	
What could you do in the next two years?	
What is the next practical step you could do?	