Islands Diversity for Science Education

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The IDiverSE guide

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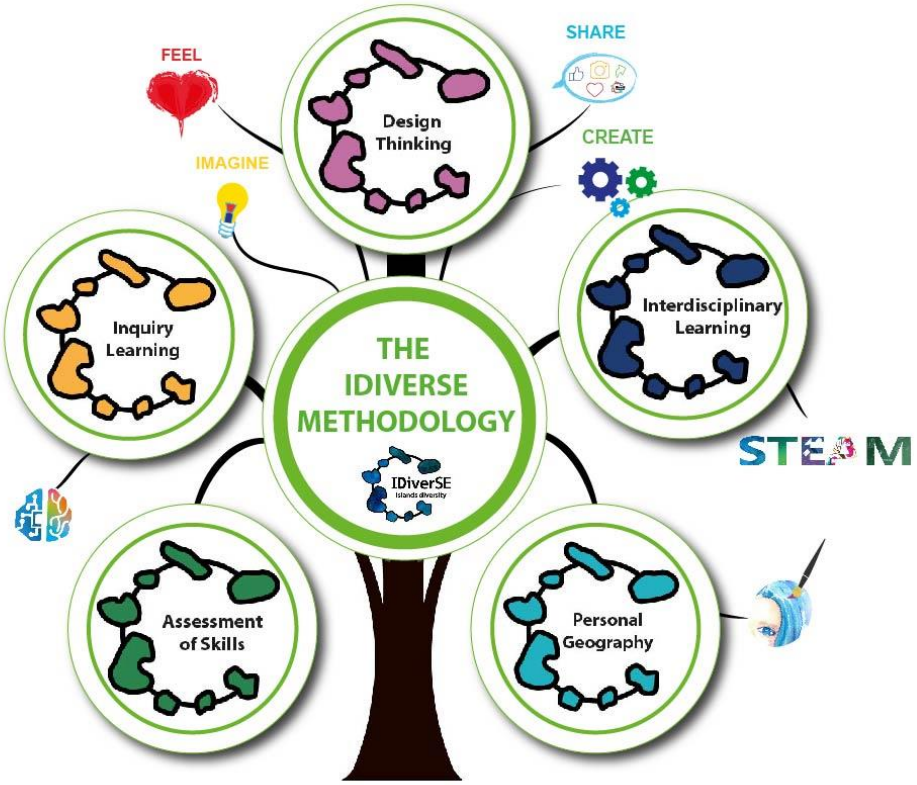
1 Introduction

IDiverSE is a project that aims at providing teachers with a full set of activities related to topics relevant to the life on islands as well as the basic guidelines that will allow teachers to develop their own activities, extending their reach by merging science with local culture references and community relevant issues. These activities will include different components, that together will approach the students learning experience in a holistic way that portraits the methodology of the project as a whole:



1. A major focus is given to the **community** where the school is involved, by introducing the **design thinking methodology** where the student goes to the community to retrieve important data and creates a product meaningful for the community using this data. The community becomes an integral part of the school work as the school becomes an important development force for the community.

2. The **Inquiry-Based Learning** approach is integrated in all the IDiverSE activities as a way of promoting fundamental skills and competences in the students that are now

being educated for the 21st century. The teachers will be supported through training and through the use of the **Inquiry Under the Microscope toolkit**, which describes a step-by-step approach for the shifting of the teaching practice to an Inquiry-based approach. As such, the IDiverSE methodology is in line with several important documents such as the OECD publication "*The future of education and skills. Education 2030*", the European's commission "*White Paper on the Future of Europe*", and the Portuguese Ministry of Education's document: Education's "*Profile of the students when coming out of compulsory school*" (translated form the Portuguese: *Perfil dos Alunos à Saída da Escolaridade Obrigatória*).

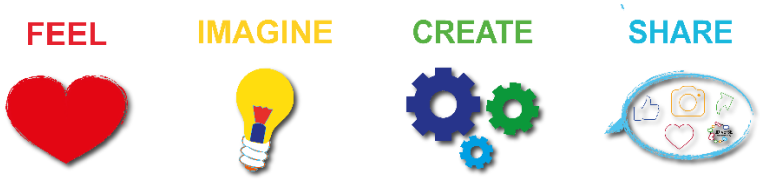
3. **Collaborative Inquiry** will be integrated in all the activities, promoting communication and collaboration between students from the different islands who will exchange ideas and best-practices form their communities. This will also allow for a global view of the challenges but also the privileges of the life on islands.
4. **Interdisciplinary** is promoted throughout the way by supporting collaboration between teachers from different disciplines as well as through **the Interdisciplinary Map of Science Ideas** which allows teachers to find relevant connections between the topics they teach and bring an interdisciplinary approach into their practice.
5. An important focus is given to the emotional development and emotional integration of knowledge that is different in all. For this, a component called **personal geography** has been integrated, which aims at artistically representing different experiences and perspectives from students progressively as they go through the activities.

This document explains in detail the different components of the project and how they will relate to each other throughout the implementation.

2 Tools for designing and implementing IDiverSE activities

IDiverSE schools will have at their disposal several tools and complementary teaching methodologies in order to implement existing IDiverSE activities or design their own. More specifically in the sections below we present the tools that will comprise the IDiverSE methodology for designing and implementing activities.

2.1 Design Thinking



The main pillar of this project, leading to the creation of the final Science Trails is the collection of local culture references and community relevant issues. The methodology used to reach this is the Design Thinking methodology. This methodology has been widely used in the business sector and has now started to be integrated in the education world. It allows students to deeply and meaningfully communicate with their community, look at the world through the perspective of their community and discover main relevant issues that should be worked on. The goal is for students to work on topics that are relevant for their community, discover how their community is behaving toward the topic and create a final output that will be practical and directly applicable, promoting awareness and community development.

In IDiverSE, the Design Thinking methodology will follow 4 steps: Feel, Imagine, Create and Share. We leave you here with a brief explanation of each step with a link to a YouTube video that describes it:

1. **Feel** – This is the first encounter with any given problem. It asks students to slow down, and deeply learn about the problem and all its perspectives before jumping to create solutions. It develops Empathy and research.

2. **Imagine** – This step is about being creative and opening the mind to all possible solutions. How can a problem be solved? How can it be solved here and now? It asks students to brainstorm and release all possible ideas before choosing which ones they will carry out. It develops creativity and communication.

3. **Create** – This step is the most interactive as it is the moment where the chosen ideas are put into practice. Students develop problem solving, critical thinking, creativity and collaboration.

4. **Share** – The final step is the moment when students share they work with others. Their solutions can actually make a difference in this world if only they share it with others and promote awareness.

2.1.1 How to implement it

All IDiverSE activities follow the four steps of the Design Thinking methodology. Throughout the implementation of the activities, students will follow these steps (see table 1) that will lead them deeply inside the problem (or topic) at hands, allowing them to create meaningful and practical solutions, directly targeted to their island and community. All the activities come with a complete set of guidelines for the teacher and for the student. After this, students will be experienced in the methodology and will, themselves, with the guidance of the teachers, follow the same steps in order to collect enough data for the creation of the final Science Trail.

2.2 Inquiry-Based Learning

One of the major problems that education is facing today is the lack of interest and disengagement of students from school. While the world is evolving at such a fast pace that almost all the knowledge can be obtained by making a quick search on a smartphone, many schools seem to maintain the same methods as 100 years ago. It is ever clearer that in this 21st century it becomes pointless to ask students to remain sited for hours, with no technology at hand, listening to a teacher talking. While many students are still able to memorize the knowledge and pass the exams, after a short period of time, most forget what they have learned or are incapable of transferring it to other situations.

As the future becomes so complex and students have the possibility of being whatever they want, it is nearly impossible to predict what career they will follow. Many students won't even follow one career but will work in many jobs and maybe even invent new ones. This means that, more than a list of pieces of knowledge to be memorized, students need to be stimulated to develop certain key skills that will make them resilient, creative and successful in whatever future they pursue.
Inquiry is just that! It teaches students how to learn, how to be critical and solve problems and allows them to explore their creativity and group work ability.

Inquiry-Based Learning is a methodology through which students become active in their own learning by following the steps of science research. Instead of going into class and transmitting to students a certain amount of knowledge that they have to memorize, through Inquiry, the teacher creates a scenario where the student will go through a project, beginning with a question, making hypotheses and experiments to test the hypotheses and reach conclusions on their own. The teacher plays a major guiding role, while students follows their own path of discovery.

2.2.1 How to implement it

In IDiverSE teachers will have access to the "Inquiry Under the Microscope" toolkit (http://platon.ea.gr/content/inquiry-under-microscope) that introduces inquiry-based learning in a step by step way, leading the teacher to gradually and comfortably activate different attitudes and promote different practical and cognitive stimuli to their students throughout the inquiry process. These inquiry components are meant to be integrated in teachers' everyday practice in the form of on-going and progressive small adaptations. This gradual integration of inquiry into everyday teaching will help teachers upgrade their teaching approach as a whole and help them implement the inquiry approach more efficiently, even when they have very limited time at their disposal. The "Inquiry Under the Microscope" toolkit and the inquiry components included there were developed during the PLATON project (2016-1-PT01-KA201- 022881). The inquiry components (IC) are presented below:

IC1: Setting the scene

IC2: Refreshing prior knowledge

IC3: Wondering about how something works

IC4: Thinking about how to test hypotheses

IC5: Doing research and collecting data

IC6: Interpreting data and drawing conclusions

IC7: Comparing conclusions to hypothesis and existing theory

IC8: Reviewing and reflecting on what has been done

IC9: Discussing and connecting with everyday life

The inquiry components can be deployed when implementing any inquiry activity, regardless of the project. Although IDiverSE activities follow a 4-step design thinking structure, as explained above, these are fully in line with the inquiry-based learning approach. Even though inquiry-based learning might be presented with no connection to design thinking, the design thinking methodology is, itself, a type of inquiry divided in 4 phases. Thus, IDiverSE activities, although they follow the four-steps of design thinking they are completely inquiry based. In some cases, parts of IDiverSE activities are even intergraded in an online platform where students will need to visit and go through an inquiry scenario to do further research on a specific topic. In addition, Eco-schools (who is a partner in IDiverSE, and several Eco-schools are going to participate), already use a similar inquiry approach comprised of 7 steps for their activities.

In order to make the connection between the four steps of design thinking, the Inquiry components presented above and the 7-steps inquiry of eco-schools more evident we present these approaches and their correlation in the table below. Looking at this table we can clearly see that, although the different methodologies follow different steps, they all focus on the same principles and work process.

Table 1: Connection between Design Thinking, Inquiry Components and the seven Steps towards becoming an Eco-school

Design Thinking Step	Most relevant Inquiry Components	Eco-Schools 7 Steps
Feel The student dives deep in the problem	**IC1:** Setting the scene **IC3:** Wondering about how something works **IC5:** Doing research and collecting data **IC6:** Interpreting data and drawing conclusions **IC7:** Comparing conclusions to hypothesis and existing theory **IC9:** Discussing and connecting with everyday life	**1. Eco Schools Committee** The Eco-Schools Committee is formed by the students and is the driving force behind the Eco-Schools process and will represent the ideas of the whole school **2. Environmental Review** Carrying out an environmental review helps the school to identify its current environmental impact and highlights the good, the bad and the ugly **Curriculum work / interdisciplinarity** Besides increasing the status of the programme, linking Eco-Schools activities to the curriculum ensures that Eco-Schools is truly integrated within the school community
Imagine Students start imagining solutions for the problem	**IC2:** Refreshing prior knowledge **IC3:** Wondering about how something works **IC4:** Thinking about how to test hypotheses **IC8:** Reviewing and reflecting on what has been done	**3. Action Plan** The Action Plan is the core of the Eco-Schools work and should be developed using the results of the Environmental Review. **Curriculum work / interdisciplinarity**
Create Students work to finding real solutions for the problem	**IC2:** Refreshing prior knowledge **IC5:** Doing research and collecting data **IC6:** Interpreting data and drawing conclusions **IC7:** Comparing conclusions to hypothesis and existing theory **IC8:** Reviewing and reflecting on what has been done	**Action** Put the plan into action **4. Monitoring & Evaluation** To find out whether or not the targets set out in the plan of action are being successfully achieved, you must monitor and measure your progress.

Share Students share their work and solutions with their class and community	**IC1:** Setting the scene **IC2:** Refreshing prior knowledge **IC8:** Reviewing and reflecting on what has been done **IC9:** Discussing and connecting with everyday life	**6. Informing & Involving** Getting everyone on board! Actions should not just be confined to the school: for example, pupils should take home ideas to put into practice. **6. Eco-code** A statement that represents the school's commitment to the environment

While working with inquiry, teachers need to consider two key points:

a) The integration process is gradual and on-going. It will be a process of trial and error until they discover what works for them and their students.

b) Teacher should not be disappointed if their first trials are not in line with what they anticipated. There needs to be an adjustment period for them and their students. The final result, the eagerness and active participation they will receive from their students will not disappoint them.

Details on each part of the activities as well as the Design Thinking methodology used are available online on the project's website, in the *Activity template with guidelines* document.

2.3 Collaborative Inquiry Cycle

Inquiry-based learning is a teaching approach that teachers can deploy in their class and have students work individually or in small groups. Collaborative inquiry takes the notion of inquiry a step further and brings in the aspect of collaboration and exchange of data between students coming from different schools and areas throughout the different phases of the process. In IDiverSE, this will be an international collaboration between students and teachers from the different islands of the project, where they can compare the situation of the different islands regarding any specific topic at hand, determine if their island is doing better, equal or worse than the others and collaborate in the exchange of ideas and good-practices.

In IDiverSE, relevance is allocated to the easiness of access to internet and digital devices. Such access allows not only for the collaboration between students from different locations on

Earth, but the inclusion of citizen science components. Taking advantage of all this, a platform called Globallab was created which allows for:

"*the practice of crowd-sourced student-scientist partnerships where students stream locally-captured time- and location-stamped data for use by scientists in their endeavours, getting in return feedback, advice, and much needed motivation for learning*." (Berenfeld, B. et al., 2014).

With access to such platform, students will engage the Collaborative Inquiry Cycle, as presented below, while collecting data in a collaborative way and communicating with students who are participating in the same project.

Figure 1. Collaborative Inquiry Cycle

With such collaboration, we expect that students will develop a more global view of the world, transfer their local knowledge to a global perspective and develop fundamental skills of tolerance and respect for diversity

2.3.1 How to implement it

Each activity will include an already prepared data collection protocol, to be followed equally by all during the investigation in order to keep consistency in the collection of data and data analysis. Furthermore, a chat platform will be provided for teachers and for students where communication between islands can occur.

The teacher should make sure that the students understand the protocol, are able to collect the data, carefully respecting all the steps and that they communicate with at least one student from a different country. This will be fundamental for having a consistent set of data that allows for a collaborative international comparison of result.

2.4 Interdisciplinarity

Interdisciplinary in the school is an approach that integrates two or more subject domains in a way that creates a meaningful and contextualized learning scenario, and which increases the understanding of each of the subjects involved as well as their connections. Nature is composed of complex systems that are interconnected and dependent on each other. Although different subjects might explain certain phenomena of the natural world in a very specific and rigorous way, in isolation they can never represent the natural systems that compose our real world. Different disciplines are not isolated from each-other. By separating them, knowledge becomes distant from reality and the real world which leads to students' demotivation and alienation from an otherwise very engaging learning process.

As such, in IDiverSE interdisciplinarity is promoted through collaboration between teachers of different subjects from the same school unit and through the integration of an interdisciplinary scenario in class which gives students the bigger picture about what they learn.

2.4.1 How to implement it

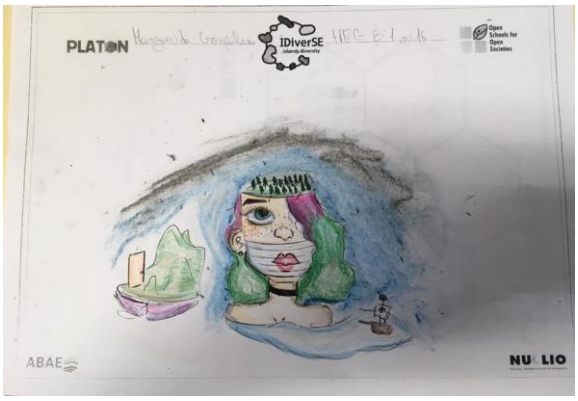
To promote interdisciplinary learning teachers will have at their disposal the Interdisciplinary Map of Science Ideas, which relates the content taught in school in different science domains through a set of 8 Big Ideas of Science.

Using this map, teachers from different subjects can discover how the topics they teach are connected with each other, bring this knowledge into the class and even coordinate their classes in order to teach related topics at the same time. Teachers can even go a step further and prepare interdisciplinary classes where the connected topics are taught under the same activity.

The Interdisciplinary Map of Science Ideas was initially developed during the PLATON project and it is available here:
http://platon.ea.gr/content/3d-interdisciplinary-map-science-ideas

The IDiverSE activities might not all be interdisciplinary on their own, however, they will include information about to which Big Ideas of Science they are related and how, as well as information about the subject domains on which it can be included. Using this information, teachers from different subjects can perform connected activities with the same students or work together in the same activity from different points of view.

2.5 Personal Geography mapping



"*A map has no vocabulary, no lexicon of precise meanings. It communicates in lines, hues, tones, coded symbols, and empty spaces, much like music [...] A map provides no answers. It only suggests where to look: Discover this, re-examine that, put one thing in relation to another, orient yourself, begin here ... Sometimes a map speaks in terms of physical geography, but just as often it muses on the jagged terrain of the heart, the distant vistas of memory, or the fantastic landscapes of dreams.*"

- Miles Harvey, The Island of Lost Maps

When a student enters the class each day, he/she brings a full pack of feelings, memories and thoughts that are completely different from every other student. Each student has a past that has shaped his/her view of the world that only he/she can understand. If we look at this fact with enough attention, we can understand that while sitting in the same class and listening to the same teacher saying the same things and going through the same activities, regardless of what they may be, each student will experience it differently and give a different meaning to it.

Personal Geography mapping is an artistic way of representing and expressing personal memories, feelings, dreams, ideas, etc. While it may be executed merely with artistic purposes, in IDiverSE it is introduced to the schooling scenario as a way of promoting for each student a self-reflection of how each experience impacted their life, thoughts, personality, etc and better understand his/her own reality as well as to share it with others. At the same time, it becomes an artistic expression of the impact of each activity which promotes artistic skills as well as personal skills such as self-reflection and awareness.

2.5.1 How to implement it

At the beginning of the implementation of the project, before any introduction or speech has been made about it, students will be given a paper and coloured pens or pencils and will be asked to make a drawing of what their island means to them. The drawing can be abstract or

concrete and students can add as many components as they want. Students will be informed that it is a very personal work and that they may decide whether to share it with their colleagues and even with the teachers or not. However, they must save it during the whole implementation as they will progressively change it and add things to it as they go through the different activities.

After they finish their first drawing, the students who wish to share their drawing will need to take a picture of it and save it carefully in a place where they can keep track of it. Then, they will add things to it every week, every month, by the end of each activity, or with whatever frequency they prefer.

We recommend that teachers choose at least 3 other moments throughout the implementation for their students to take a picture of their drawing. By the end, we propose that each student makes a montage with 4 pictures including the first drawing, the last drawing and two of their choice in between. This will then be integrated in their final portfolio. Remember, however, to respect in case some of your students don't want to share it. This is meant to be mostly done for personal development and reflection.

2.6 Students' portfolio

The students' portfolio will reflect the work developed by the students throughout the project and will include the selection of pictures taken from the personal geography mapping. This should be created in groups as a continuous process. The group can be a school group, a class group or a work group within the class, however, it should always be a heterogeneous group in terms of gender, personality, origin, etc.

2.6.1 How to implement it

Students will be encouraged to document their work in the form of e-portfolios using a free online e-book maker. E-portfolios are easy to make collaboratively so it would be convenient for students to work on them together simultaneously either at school or from home. In addition, the tools offered by e-book platforms can turn the students' portfolios in very attractive and elegant magazine-like products which students can later choose to use in their science trails. In order for the portfolios of the students to be coherent in an international framework, we propose that all the groups include the following elements:

1- Personal Geography

Each student includes the montage with the photos of his/her personal geography and any other introductions, pictures, drawings that may be relevant as an introduction and as an ongoing process. The group can also include a text, pictures, drawings, reflections, made in group.

2- A lot, a little and so-so

The group should choose to reflect about the activities implemented that, for some reason, have been significant for them. Students might decide to highlight aspects of the activities that were positive, negative or indifferent to them.

Regarding each activity it is important to mention:

- title of the activity;
- date in which it was implemented;
- signature of members who contributed;
- what has been learned from the activity;

- Positive/negative/indifferent aspects of the activity and reason why;

- Why the activity has been selected to be included in the portfolio;

- Pictures and other relevant records.

3- Our IDiverSE legacy

In this section, periodic reflections about the work that has been developed individually or in a group and with the community must be included. The frequency must be negotiated and be clear between the students and the teacher.

The reflections can be initially guided by the teacher with the suggestion of certain sentences that should be answered in different stages of the process, like:

- For me IDiverSE is…

- To live on this island represents…

- For me the problems and difficulties I face for living on this island are…

- What I like the most on this island is ...

Throughout the implementation, students can return to those sentences and write them again, in case something has changed.

4- Comments

This is where comments from the teacher, the parents, friends, members of the community, etc can be included whenever relevant.

2.7 Science Trails

After getting acquainted with the Design Thinking methodology and the research method, students will be prepared to take charge of the process that will lead to the creation of their own projects which will lead to the creation of the Science trail of their island, highlighting relevant cultural references. During this process, students will investigate their community, reflect on the most relevant topics that should be worked on (some of them might already have been worked on during the activities), solved or enhanced and highlight relevant cultural references. While working on their activities they will also start preparing their science trail for their island. The science trail will be a physical trail with stations which students will use to contact local citizens and raise their awareness on the topics they worked on. To make their science trail students will use the materials they will create during their projects. They will also work together with their community members on the creation of very relevant stations of their trails.

2.7.1 How to implement it

Students use the Personal Geography and will follow the 4 steps of the Design Thinking in order to select the most meaningful topics to be developed for the stations of the trail and create meaningful stations for the community. Each station should approach a different topic, raising awareness for it. Students should choose topics regarding which their community needs to develop, but also topics regarding which their community might me exemplary or very well developed. It is important to give relevance to the positive aspects of the community as well.

The stations should be placed in an open area where all members of the community can visit and enrol in each station. Proper publicity should take place so that the trail has maximum visibility within the community and reach as many people as possible.

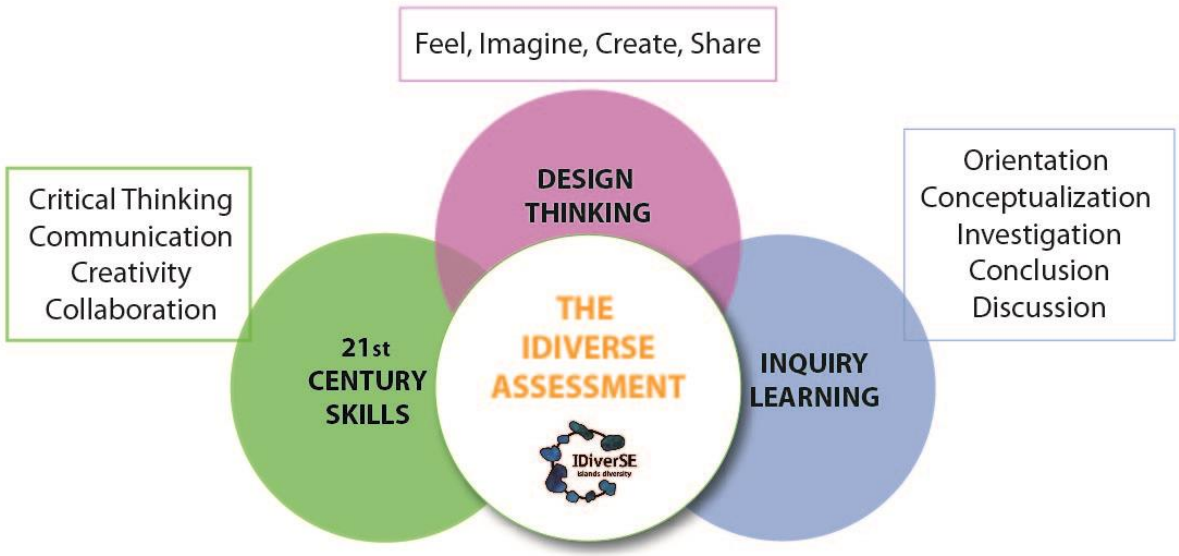
3 Assessment

As it was illustrated in this document, so far, the methodological approach of IDiverSE seeks a global development of the student through the rigorous application of the scientific method, the resolution of real problems and active collaboration with social stakeholders in their environment. As such, the main aim of the IDiverSE assessment approach is not only to measure a certain level of development or mastery in these areas, but also to guide students

on how to improve their learning, providing them with the necessary tools and indications so that they can advance in their learning process. This formative assessment approach seeks to provide feedback to students which allows them to be aware of their learning, helping them to be strategic and to direct their motivation towards the learning objectives. For this reason, the students' learning assessment process is a relevant factor within the pedagogical framework of IDiverSE.

IDiverSE assessment focuses on student learning in three fundamental areas: the development of 21st century skills, the development of inquiry skills, and the development of design thinking skills.

Within this competency-based assessment approach, it must be borne in mind that skills are not observable by themselves; therefore, they must be inferred through specific student actions. In this sense, IDiverSE provides the teacher with assessment criteria and tools to collect observed evidence from students throughout the process and integrate it into the overall assessment. In addition, it provides teacher with analytical and technological tools that automatically collect evidence of student performance. Using this kind of analytical tools, students can review their progress and teachers can adapt their methodologies according to students' needs.



3.1.1 How to implement it

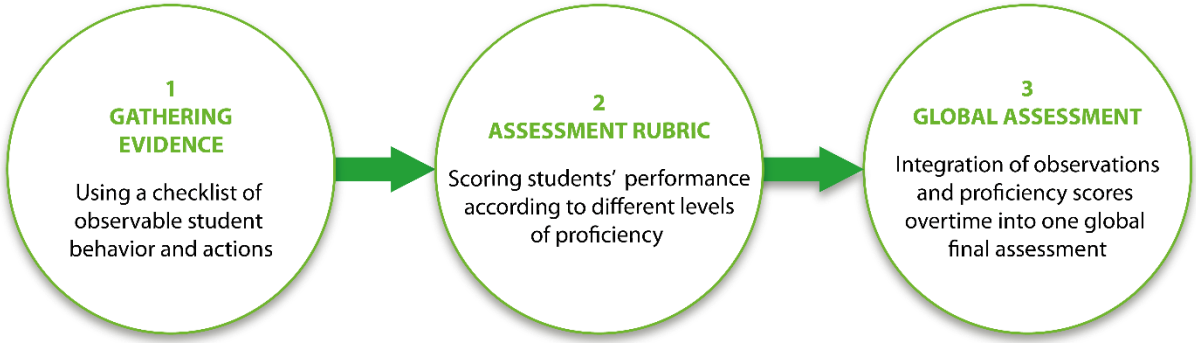
The teachers will take as a reference a formative and global evaluation approach based on the student's performance in three fundamental areas:

- XXI century skills
- Inquiry Learning
- Design thinking

For this purpose, teachers will have as a reference a rubric with evaluation indicators referring to each of these areas and with different levels of mastery.

In addition, teachers will have an IDiverSE assessment protocol in which different evaluation moments to collect evidences are highlighted. This protocol provides guidelines on how to integrate all the evidence from the students and how to send so that they can improve and reorient their learning, if necessary.

In this way, IDiverSE seeks to provide resources to teachers to ensure meaningful and lasting learning for their students.



4 IDiverSE activities overall structure, rational and implementation phases

4.1 IDiverSE activities overall structure and rational

Schools participating in the projects will be invited to implement activities that regardless their individual topics, all share the same spirit, reflected on the following line: *"Me in my island, my island in me"*

The main structure of the activities will be the four steps of design thinking while they will deploy all the tools mentioned above in a meaningful and well-orchestrated way as presented below:

FEEL

My island in me

Students use the personal geography tool to reflect on what their island means to them, what are the most major problems according to their understanding and what are the strong points of their traditions/culture and local society.

Tools deployed: Design thinking, Personal Geography

IMAGINE

CREATE

IDiverSE project

Students contemplate on the problems they thought of in the previous part and decide the topic of their IDiverSE project. During the implementation students will get in touch with schools from other islands using the collaborative inquiry tools. Teachers will use the inquiry components to help their students work in a scientific way while they will also use the interdisciplinary map of ideas to help their students understand the interdisciplinary nature of the problem and combine knowledge from different science disciplines in order to solve it. Throughout the process students will use their portfolios to document their work and keep track of their actions. At the same time, based on the new things they learn they will also enrich their personal geography map. Teachers will use the assement tools to monitor the process.

Tools deployed: Design thinking, inquiry-based learning, collaborative learning, interdisciplinary learning, students' portfolio, Personal Geography, assessment tools

SHARE

Me in my island

Students create their science trail based on their activities and the materials they created (personal maps, portfolio and project outcomes, to present their work in the local community. Through the science trail they make their presence strong in their island by becoming active citizens and influencers.

Tools deployed: Design thinking, Science Trails, students' portfolio, Personal Geography

4.2 Implementation phases of the project

The IDiverSE implementation will include two different phases, each of them divided in different steps:

1st phase: Implementation of the IDiverSE activities

2nd phase: Creation of the Science trails

4.2.1 1st phase: Implementation of the IDiverSE activities

During the first phase of the project students will implement the IDiverSE activities, experiencing in first-hand the Design Thinking methodology, as well as the collaborative Inquiry, in an interdisciplinary approach.

All the IDiverSE activities will be accommodated in an online platform called OSOS (http://portal.opendiscoveryspace.eu/en/osos) and will also be available in paper form in the project website (http://idiverse.eu/).

Each activity includes several documents that provide a theoretical framework for the teacher as well as complete guidelines that will provide all the support and comfort for their implementation. At all times, the IDiverSE team will be available to answer all the questions and give all the necessary support.

Steps to be taken:

1. Collaborate with at least one colleague of the same school, from a different subject domain
2. Students make the first drawing of the Personal Geography map.
3. Explain the project to the students (highlight the fact that they will be working in collaboration with students from other islands)
4. Implement at least 1 IDiverSE activity with the students

a. Continuously add new elements to the Personal Geography drawing
b. Progressively fill in the portfolios

4.2.2 2nd phase: Creation of the Science trails

Students will focus on their island and take charge of their own Design Thinking process through which they will create the stations for their Science Trails.

a. Continuously add new elements to the Personal Geography drawing
b. Progressively fill in the portfolios

References

Ananiadou, K., & Claro, M. (2009). 21st century skills and competences for new millennium learners in OECD countries.

Berry, J. K. (2011) *Personal Geographies: Explorations in Mixed-Media Mapmaking,* Illustrated (Eds.), F&w Publications Inc, 2011

Berenfeld, B., Krupa, T., Lebedev, A., & Stafeev, S. (2014). When Everyone Is a Probe, Everyone Is a Learner. International Association for Development of the Information Society.

Brown, T., & Wyatt, J. (2010). Design thinking for social innovation. Development Outreach, 12(1), 29-43.

Eleftheria, T., Sotiriou, S., & Doran, R. (2015). The "Big Ideas of Science" for the school classroom: Promoting interdisciplinary activities and the interconnection of the science subjects taught in primary and secondary education. *EDITORIAL BOARD*, 72.

European Commission (2017) 'White Paper on the future of Europe': https://europa.eu/european-union/ sites/europaeu/files/whitepaper_en.pdf

Harlen, W. (Ed.). (2010). Principles and big ideas of science education. Association for Science Education.

Howells, K. (2018). The future of education and skills: education 2030: the future we want, OECD: https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf

Lenoir, Y., & Hasni, A. (2016). Interdisciplinarity in Primary and Secondary School: Issues and Perspectives. *Creative Education*, *7*(16), 2433.

Martins, G. D. O., Gomes, C. A. S., Brocardo, J., Pedroso, J. V., Camilo, J. L. A., Silva, L. M. U., ... & Rodrigues, S. M. C. V. (2017). Perfil dos alunos à saída da escolaridade obrigatória

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., ... & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. Educational research review, 14, 47-61.

PLATON Roadmap Towards Innovation - A step-by-step guide for teachers (2018) http://platon.ea.gr/content/platon-roadmap-towards-innovation

You, H. S. (2017). Why Teach Science with an Interdisciplinary Approach: History, Trends, and Conceptual Frameworks. *Journal of Education and Learning*, *6*(4), 66.