LEARNING ABOUT STEAM THROUGH THE RESOLUTION OF REAL PROBLEMS AND THE INVOLVEMENT OF LOCAL STAKEHOLDERS

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Abstract

Many innovative initiatives serve to transform the way our students learn. However, not all the proposed initiatives interest our students because they do not address real problems or because they are disconnected from the reality of their environment. Through the Islands Diversity for Science Education project, students from islands around the world will be able to collaborate and learn relevant content by applying the scientific method and analysing local and global data. It's an innovative, collaborative, experiential, and durable way to learn science.

Islands Diversity for Science Education (http://idiverse.eu/) is an educational project, co-funded by the European Erasmus + Agency, which proposes an innovative methodology focusing on scientific knowledge and bringing students to the heart of their community to raise important issues and create relevant and directly applicable solutions with lasting effect.

The aim of this project is to offer a methodology for teaching scientific areas based on the exploration of the environment, in the identification of real problems related to biology, geology, astronomy, or physics, for example, so that students can gather information to better understand the problem, advance in knowledge and even propose creative solutions.

To achieve this objective the project provide training and educational resources to schools to become open schools, as well as a set of activities based on scientific areas where students develop projects that address the real needs of their community and their environment, following the Design Thinking methodology in an interdisciplinary and Inquiry-based approach.

One important pillar of the project and a central objective of the methodology is the inclusion of an assessment protocol focused on the development of 21st century skills. This assessment protocol focuses on the collection of evidence, observation by the teacher, and the integration of data extracted from the technologies themselves (a contribution from the field of Learning Analytics). This article presents the assessment protocol designed for the project's methodological approach. This assessment protocol makes possible to assess, based on evidence, the research activities carried out by the students and their development of critical thinking, communication, collaboration and creativity skills. Since the development of competencies and the application of the scientific method are learning objectives common to all these disciplines.

The implementation of this methodological approach is being widely welcomed by science teachers for the interdisciplinarity of learning activities, and by students for the authenticity of learning experiences. In addition, external stakeholders such as families, associations or local companies have also shown their interest in the project and have positively valued the opportunity to be part of these learning experiences.

There are already several kindergarten, primary, secondary, baccalaureate and even vocational schools in Portugal, Greece and Spain, among others, that are implementing the IDiverSE methodology. This article presents the assessment protocol designed for the project and a series of examples of good practices from schools that are successfully implementing this methodology in their islands and that are succeeding in involving stakeholders of their environment in projects to find solutions to real problems that affect students, and their communities.

Keywords: STEM education, Design Thinking, 21st century skills, assessment, Learning Analytics.

1 INTRODUCTION

Islands host a very important patrimony of natural and cultural assets. Containing specific traits of flora and fauna, their own climate and cultural heritage, islands accommodate a perfect environment for science education to be promoted. One of the listed measures to diminish the impact of isolation and

boost development in the islands is to promote the use of new ICT tools in education [1]. For this, iDiverSE project seeks students can discover the value of their natural and local culture, while with the use of ICT they can share their discoveries with the outside world thus promoting the richness of their homelands. IDiverSE brings innovation to the school environment and open the school to the community, namely based on outdoors pathways where people experience science, through hands-on activities and observing natural phenomena.

IDiverSE project implements science learning in the classroom in the resemblance of real science work, and inquiry based learning activities in the context of natural and cultural heritage promoting student involvement and proactivity. iDiverSE activities can be downloaded from the project website (https://idiverse.eu/activities/) and deal with diverse and attractive topics such as: bees for the future, our restless earth, plastics in the ocean, the shape of the earth, soil for life or stars in the sky.

This project is creating an international network where different isolated groups become a strong, relevant and diverse community, thanks to cooperation and joint efforts between schools from different islands.

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2 METHODOLOGY

IDiverSE assessment focuses on assessing student learning in three fundamental areas: the Design thinking, the Collaborative Inquiry and the 21st century skills. 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.

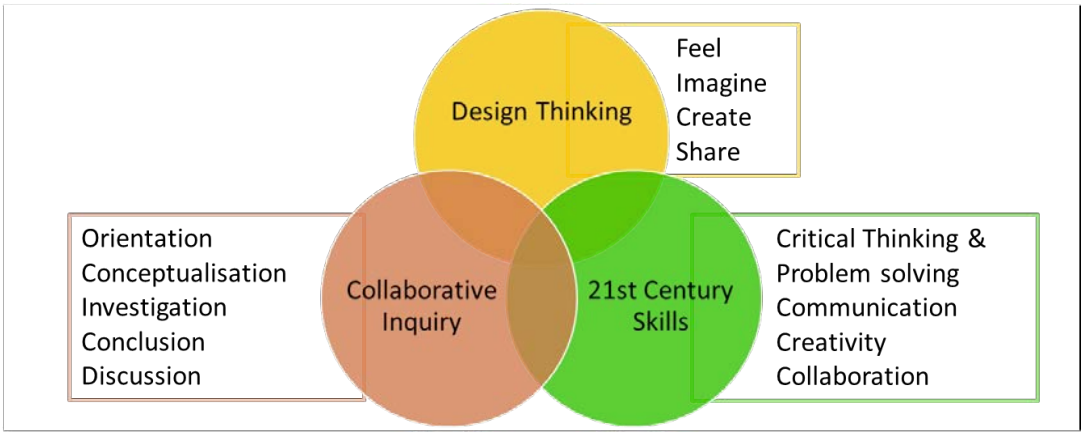


Figure 1. Components of iDiverSE pedagogical framework

The main aim in IDiverSE assessment 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 of IDiverSE seeks to give feedback to students so that they are aware of their learning, to help them to be strategic and to direct their motivation towards the learning objectives.

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 approach to assessment. This assessment approach base on processes, that is, since it focuses on the collection of information on student behaviour, on cognitive, affective and social aspects, and on analysing how learning is taking place [2]. In addition, it provides them with analytical and technological tools that automatically collect evidence of student performance. Thanks to this kind of analytical tools, students can review their progress and teachers can adapt their methodologies according to students' needs.

2.1 Global Assessment Tool

Competence assessment involves generating relevant information and using a privileged instrument to manage the integrated acquisition of knowledge and action [3]. The tool that has been designed to help IDiverSE teachers carry out the assessment of the student's activity is the Global Assessment Tool.

The first action when teacher uses the Global Assessment Tool is to identify how many students are in the classroom. It is possible too to do the assessment by workgroups and not individually. If the teacher has 20 students, he/she will write “20” in the “config” sheet. If the teacher wants to do the assessment by workgroups and he/she has five groups, he/she will write “5” in the blue cian cell of the “config” sheet. After that, automatically one new sheet per student/workgroup will appear in the spreadsheet, and in the “global” sheet, this number or student/workgroup will be aggregated for the final global assessment.

The specific instructions given to the teacher to use the template are as follows:

1 Change the number of students [positive - between 2 and 50]

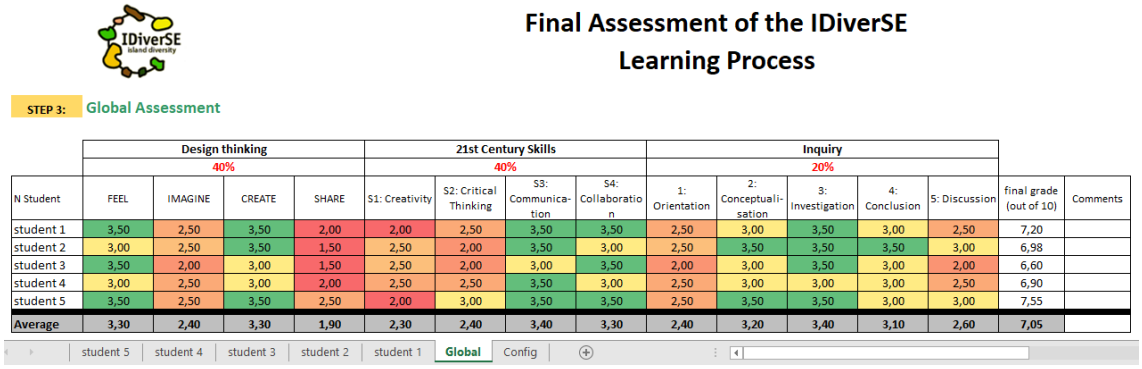
2 Press the "CREATE" button

3 Wait some seconds to sheets to be created

4 Sheet "Global" will have a row for each student

It´s very important not change the structure of sheets or data formulas, because it might stop working.

In the figure 2, we can see the Global Assessment template with five rows corresponding to five students and in the lower part, the different sheets for each of the students, and the configuration label.



Final Assessment of the IDiverSE Learning Process

STEP 3: Global Assessment

	Design thinking				21st Century Skills				Inquiry						
	40%				40%				20%						
N Student	FEEL	IMAGINE	CREATE	SHARE	S1: Creativity	S2: Critical Thinking	S3: Communica-tion	S4: Collaboratio n	1: Orientation	2: Conceptuali-sation	3: Investigation	4: Conclusion	5: Discussion	final grade (out of 10)	Comments
student 1	3,50	2,50	3,50	2,00	2,00	2,50	3,50	3,50	2,50	3,00	3,50	3,00	2,50	7,20	
student 2	3,00	2,50	3,50	1,50	2,50	2,00	3,50	3,00	2,50	3,50	3,50	3,50	3,00	6,98	
student 3	3,50	2,00	3,00	1,50	2,50	2,00	3,00	3,50	2,00	3,00	3,50	3,00	2,00	6,60	
student 4	3,00	2,50	3,00	2,00	2,50	2,50	3,50	3,00	2,50	3,00	3,00	3,00	2,50	6,90	
student 5	3,50	2,50	3,50	2,50	2,00	3,00	3,50	3,50	2,50	3,50	3,50	3,00	3,00	7,55	
Average	3,30	2,40	3,30	1,90	2,30	2,40	3,40	3,30	2,40	3,20	3,40	3,10	2,60	7,05	

Figure 2. Global Assessment Tool

In the Global Assessment Tool there are three different steps:

1 *Gathering evidences*: the teacher has a checklist to register observable behaviours in the classroom.

2 *Assessment rubrics*: the teacher also has scoring guides describing the students´ performance at various levels of proficiency. After the checklist, the teacher can relate the evidence collected with the proficiency levels of the rubric.

3 *Global Assessment*: lastly, the teacher has a sheet that integrates the global assessment of the students based on the previous rubrics. The tool copies automatically all the grades in the “global” sheet to obtain the final grade. In this global sheet, the teacher can personalize the weight assigned to each area of the IDiverSE methodology. In order to do this, it is enough to change

the percentages that appear in red below the section of each area. The formula would recalculate based on the new percentage assignment.

In the figure 3, we observe the first two steps corresponding to the assessment of the Design Thinking component. First, the checklist to collect evidence appears and second, the rubric of this component of the global assessment. In addition, there is an automatic column chart showing the progress of each student based on the rubric. The teacher can compare the results of the intermediate and final assessment of the students and even generate graphs automatically. These graphs could be used when sending follow-up reports to students.

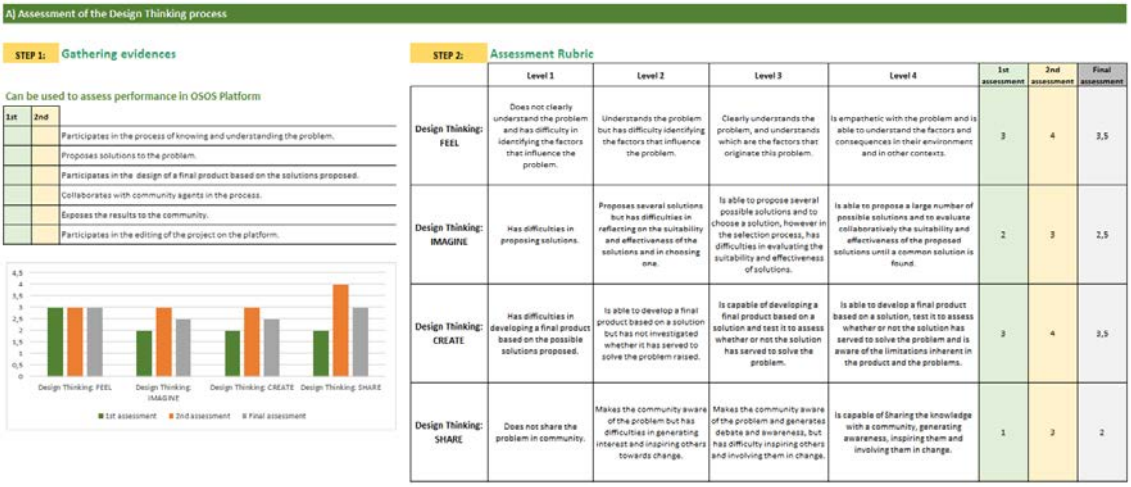


Figure 3. Assessment of the Design Thinking component

It is advisable for the teacher to send feedback and individual reports of this formative assessment to the students so that they are aware of what their real performance has been. The formative assessment implies a process of monitoring and constant follow-up with the intention of collecting and sharing information that can be useful to improve learning and that also allows to improve future learning activities [4]. Feedback plays a crucial role in regulating learning processes [5], [6], [7], as it allows students to monitor their progress towards their learning goals, adjust their strategies to achieve the goals, and ultimately favours self-regulated learning [8]. For this reason, the assessment is considered one of the fundamental pillars in the methodological approach of the idiverSE project.

3 RESULTS

Currently 11 schools in Portugal, 19 schools in Greece and 5 schools in Spain are implementing the iDiverSE methodology. These schools are geographically located on islands in these three countries, such as Kalymnos, Rhodes Mytilene, Azores, Madeira, Tenerife, Gran Canaria and Mallorca.

Through these schools, more than 800 students are benefiting from the iDiverSE methodology and approximately 65 teachers are involved in this training plan of the STEAM areas. Most of the teachers that implement iDiverSE are middle and secondary science, environment, technology and mathematics teachers.

Una de las actividades más populares del Proyecto es “Bees for the future”. In this activity students discover what is the importance of bees for human life as well as for the whole ecosystem and investigate how their communities and the communities that live in other islands are behaving towards bees. Bees are a major contemporary science concern, as they are necessary for the pollination and consequent reproduction of most of the plants that we eat (and that the animals that we eat use to feed as well) and their numbers have been decreasing at a fast rate. Considering this, students from the different islands learn about the problem and collaboratively figure out solutions to improve community awareness and conservation strategies in the islands. Currently there are about 300 students from different schools implementing this activity, with a greater presence in schools in Portugal.

Another activity that is also having a big impact is “Restless Earth”. In this activity students explore some of Earth’s most intense and overwhelming events; volcanic eruptions, earthquakes and tsunamis. They reflect on the impact of these natural phenomena on humans and their societies. They also are

challenged to design a citizens' alert programme in order to raise awareness in the local community and help their municipality in preparing citizens for such events. Currently there are about 500 students from different schools implementing this activity, with a greater presence in schools in Greece.

4 CONCLUSIONS

This Project is an opportunity to bring young people closer to science and by empowering students living on islands to appreciate their environment, value it, understand it and care for it. It is about discovering the science that surrounds them and understanding it through real experiments and through collaborative research processes with students from other islands of the world. The project is having a very significant reception among students and teachers, and concretely the evaluation protocol has been very well valued among the teachers who are implementing the project.

The assessment tool designed for this project is a tool that is freely available to any teacher through the project platform and can also be modified according to the interests of any teacher. A very versatile tool that can be used in other learning contexts of the STEAM areas as it focuses on the assessment of general competences and scientific inquiry competences.

This assessment tool has been designed to give greater relevance to training processes in new methodological approaches and to take a step forward in terms of competence assessment. In future work and research, it would be interesting to explore the integration of peer assessment and self-assessment in the same tool.

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