Education and Museum: Cultural Heritage and Learning

Final event and
International Conference
Proceedings
Roma, 26-27 June 2017
Sapienza Università di Roma

EdMuse is a project co-funded by the Erasmus+ Programme of the Europen Union

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ΚΑΙ ΘΡΗΣΚΕΥΜΑΤΩΝ
ΠΕΡΙΦΕΡΕΙΑΚΗ Δ/ΝΣΗ Π/ΘΜΙΑΣ & Δ/ΘΜΙΑΣ
ΕΚΠ/ΣΗΣ ΔΥΤΙΚΗΣ ΕΛΛΑΔΑΣ
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46° 10/Θ ΟΛΟΗΜ. ΔΗΜ. ΣΧΟΛΕΙΟ ΠΑΤΡΩΝ

AGRUPAMENTO ESCOLAS C CENTRO

Directorate of Primary Education
of Achaia
Department of Cultural Education

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ
UNIVERSITY OF PATRAS

NUCLIO
NÚCLEO INTERACTIVO DE ASTRONOMIA

Istituto Comprensivo Via Val Maggia

In cooperation with

Michael Culture Association

EdMuse is a project co-funded by the Erasmus+ Programme of the Europen Union

EDMUSE

Education and Museum: Cultural Heritage for science learning

Start: 01-09-2015 - End: 31-08-2017
Project Reference: 2015-1-IT02-KA201-015013

Programme: Erasmus+
Key Action: Cooperation for innovation and the exchange of good practices
Action Type: Strategic Partnerships for school education
Topics: Pedagogy and didactics
Key Competences (incl. mathematics and literacy):
basic skills ICT - new technologies - digital competences

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Istituto Comprensivo Via Val Maggia (IT)
Istituto e Museo di Storia della Scienza (IT)
Nuclio Nucleo Interactivo de Astronomia Associacao (PT)
Universidade de Coimbra (PT)
Directorate of Primary Education of Achaia (EL)
Panepistimio Patron (EL)
46 dimotiko sxoleio patron (EL)

Summary
The project proposal is connected to the promotion of initiatives, starting in primary school, for using ICT, the open educational resources and digital resources of cultural heritage for the improvement science learning. The Project aim is to promote a new ways of learning and teaching through innovative method, using technologies and open digital resources that can be non-formal content for design curricula. It also proposed a new way for schools and museums cooperation; Teachers of primary school partners are involved in the project through the learning experience with students of their classes.

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PROJECT ACTIVITIES

- State of the art analysis in the use of innovative practices in science education in country partners;
- Define methodology of using technologies and digital resources for making learning units;
- Design and development platform to access and re-use digital resources of cultural heritage in education field;
- Design and development tool for making interactive and open educational resources.

Oriented educational, research-technology and museum Partners will analyze the practices adopted by different countries connected to Science teaching, European Commission document and recommendations in educational field. They also will discuss on some experiences of "best practices" to identify access modality, use and reuse of cultural heritage and the arrangements for making learner-centered teaching unit. The partner will be able to define such skills needed by teachers for working in an innovative way and therefore which practices for permanent professional development and experience sharing among teachers of different countries of the Union should be adopted.

The partners expect positive results related to:

- Teach in the classroom through multimedia tools with new approaches to the scientific disciplines for learning enhancing;
- Propose a trail for reality perception by students as an open system in which you can draw and exchange information with the help of technology;
- Constructivist theory application, creating a synergistic relationship between different learning environment;
- Develop relationships between schools, cultural institutions and in general between school, research and culture environment;
- Increase and stimulate students for Science learning.

The Project goal will be to share and exchange best practices and applications among school models of different countries, to enable the teachers training on how to design cross-disciplinary learning activities for improving a collaborative work to include scientific issues in different areas of the school curricula. Important aims will be innovative relationships between teachers and museum staff, the accessibility to resources as tools to enable teachers to create teaching units to be shared as OER (Open Educational Resources), providing students formal and no formal educational content adopting a language close to the one they use on every day. Dissemination and communication plan provides information and content of Project activities for involving and stimulating stakeholders, national and international educational agencies to replicate experimental methodology and instruments for increasing motivation of the students to choice of higher studies in science field.

DEVELOPMENT OF METHODOLOGY AND RESULTS

Previous studies show that museum resources are not systematically used in the framework of classrooms and that on site visits are not always producing the expected results in terms of learning.

These institutions also highlight the importance of emerging Information and Communication Technologies (ICT) tools to allow the embedding of such resources in the learning environment.

However, the relationship between school and museum, with the scientific and digital realities that compose it, is both an expansion of training and a fun and valuable experience for the training of students and teachers. Especially the university museum is a place of integrated culture, based on the observation of objects and the possibility of interacting with them, where the student may track through the use of “exhibits”, what he has learned, theoretically, in connection with the historical and artistic disciplines.[1]

The Erasmus + Project "Education and Museum: Cultural Heritage for learning science" aims to promote innovative methods of teaching and learning through reusing digital learning objects of museums. This aim can be achieved through the EdMuse platform that enable personalized and adaptive eLearning pathways.

THE EDMUSE PLATFORM

In the scope of EdMuse, teachers are invited to plan "teaching" units on a topic of science, selected from among the contents of the programming for targets, so as to ensure the development of core concepts of the discipline in question[2] in a multidisciplinary and transversal perspective. The goal is to give students the tools to understanding and acquire the skills as the ability to use the new knowledge. Integration with digital assets is useful when the teacher prepares his lectures. In this phase, the opportunity to

[1] V. Ferrara, S. Sapia et al., Il patrimonio digitale per la didattica, a cura di V. Ferrara, Roma: Digilab, 2014.
[2] C. Piu, Problemi e prospettive di natura didattica, Roma: Monolite Editrice, 2009.

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gain access to the digital resources of museums, constitutes a valuable support to capture images of museum objects and information connected to content related to the topic discussed in the classroom.
EdMuse methodology also allows teachers to build a custom path online. Using programs or software products, teachers can create an e-book, according to a communication strategy based on a continuous process of collaboration between the museum and the teacher, according to which they can:

- connect to the catalogue of museum objects;
- choose the content and the related images useful to describe the subject of a curricular discipline.

The student, through the thematic routes and the observation of the museum object, is involved in the discovery of ancient history, science, art and technology in a context certainly more appealing than the "traditional" classroom[3]: peoples, events of the past, tools, inventions that have been realized through the collections, the objects, the evidence preserved in the museum environment.

In summary, teachers, thanks to the methodology proposed in EdMuse:

- Acquire the skills to access the online digital resources of various museums;
- Register on the website made available to create custom locations for the storage of museum objects and the link information selected;
- Trigger the download of custom locations on your computer.

EU RECOMMENDATIONS FOR USING CULTURAL HERITAGE IN EDUCATION

The European Digital Agenda identifies as a priority the re-use of digital content related to the cultural heritage to develop learning content [EU Commission Recommendation, 711/2011 / EU]. The presence of numerous digital resources made available in open data mode of the museums will ease their reuse (EU Commission Recommendation 2011/711 / EU).

The museum objects can become a vehicle for educational content, as they can provide information related to its nature, to its use, to its representation in different historical contexts and disciplines. Being "image" and "content" they are candidates to become an effective contribution to the production of multidisciplinary and personalized educational courses.[4]

NATURAL SCIENCES DIDACTICS AND MUSEUM EDUCATION THEORETICAL MODELS

The Natural Sciences Didactics and the Museum Education followed an almost common theoretical process, passing form the behaviourism to the social constructivism, more recently combined with sociocultural approaches. That process affected the Natural Sciences Curriculums and the Educational programs of the museums, which changed their focus from the "subject" to the "learner".

Nowadays the common ground between museum education and Didactics of Natural Sciences is the theory of the constructivism. The educational theory of the constructivism considers that students construct the knowledge themselves, through social interaction and language use, and they interpret the various concepts and ideas through their personal models, which are concerto constructions, widely known in natural sciences didactics as conceptual representations. Constructivist educational theory argues that in any discussions of teaching and learning we should focus on the learner. The mains teaching goal on Natural Sciences Didactics is to help students to learn how learn, through multidisciplinary approaches, immediate experience, use of original resources and interactive initiatives.

The "hands on" and "minds on" activities of Dewey, the theories of Vygotsky and Bruner, which highlights the role of cultural background of learning and the theory of multiple intelligences of Gardner converge on using museum education in order to design and implement multidisciplinary teaching approaches.

CONSTRUCTIVIST TEACHING AND LEARNING METHODS

In order to facilitate the full development of each student, it is necessary to provide an effective strategy for learning through various educational procedures. Teachers must develop teaching learning scenarios on how to use the platform in a constructivist model. The constructivist-teaching model for the Natural Sciences evolves into five phases and is proposed to develop EdMuse multimedia lessons:

- Orientation,

[3] S. Sapia and V. Ferrara, Al Museo per fare didattica. Education 2.0, 2013.
[4] Cf. Europeana Foundation (2015). *Europeana for Education and Learning: Policy Recommendations*, <http://pro.europeana.eu/publication/europeana-for-education-policy-recommendations>, accessed 22 June 2017.

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- Promotion of children's representations,
- Reconstruction of children's representations,
- Implementation to everyday life,
- Review.

Concern of the teacher: to challenge students' interest in such a way that they feel the concept negotiated concerns them.

The stimulus must be appealing and targeted to multifaceted (emotional and cognitive) engagement of the student.

The use of interdisciplinary stimuli can reinforce the impression caused: e.g. a collection of newspaper headlines or a photographic collage of the events of an earthquake can contribute to this.

Children's representations are very important:

- Dialogue is sought to enable students to explain their views;
- Trying to explain, the student is forced to organize what he/she thinks and thus perceive possible confusions. They also have the opportunity to compare the views of their peers.

The class checks the correctness of their ideas with scientific documentation, which is experimentation and the so-called guided discovery approach.

At this point, the contribution of the platform and the museum exhibits can be decisive.

The exhibits and their observation contribute to the discovering of the scientific principles and laws labelling. Choosing the right exhibit and the didactic handling with proper presentation and appropriate questions will lead to reconstructing the previous views into scientific representations.

The platform may include proposals for teaching manipulations of exhibits or suggestions on the suitability of each exhibit for the reconstruction of certain erroneous representations of the students.

The ability of the new cognitive achievements to solve problems of reality with the scientific process is judged- checked.

The variety of everyday sectors in which everyone meets science applications can be served by the interdisciplinary approach.

The students compare their initial ideas to their reconstructed ones and a cognitive imbalance arise. Discussion leads to conclusions adopting the new knowledge.

METHOD FOR USING THE EDMUSE PLATFORM

The EdMuse Platform collects the metadata of cultural heritage objects extracted from museum catalogues, using API service, involved in the project and from the Europeana Digital Library. EdMuse Platform is a virtual learning environment based on collaborative work to share content and Learning Objects among many schools.

It aims to allow teachers to build a personalized path through web access to the Museums Catalogues and to download images and information on museum objects to be used in the production of multimedia lessons

Different modes and content have been provided in a reserved area for teachers to make online lessons integrating museum objects.

Cards and catalogues are available on the EdMuse platform, usable to any visitor who can look up and see what interests them; teachers and students logged in the project have an opportunity to create their own catalogues structuring specific paths in which they’re going to insert the objects of their interest; they have also the option to add other descriptions visible to all using the annotation tool.

The Educational Partners of Edmuse Project have access to EdMuse platform and have managed the data downloaded from it. The teachers made multimedia lessons and upload them on the platform so other teachers and student can access to this educational content. (http://www.edmuse.eu).

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Programme

MONDAY 26 JUNE

Final Event EdMuse Erasmus+ project

9:00 REGISTRATION
9:30 Welcome
Prof. Eugenio Gaudio, Rector of Sapienza University of Rome
Prof. Fabio Grasso, Director of DigiLab research Centre

10:00 Introduction to the EdMuse Project
Vincenza Ferrara, Project Coordinator
10:15 The Educational Systems of Partners
Maria Gotsopoulou
10:30 EdMuse methodology
Piedade Vaz Rebelo

10:45 COFFEE BREAK

11:00 Presentation of the EdMuse platform
Anastasios Giannaros
11:15 Multimedia Lessons (guidelines) and Museum Resources
Sonia Sapia, Marco Berni
11:45 EdMuse: Experiences in the class
Cristina Lonetti (Italy), Christina Koutsospyrou (Greece), Paulo Santos (Portugal)
12:15 Dissemination and Training experience with teachers
Rosa Doran
12:30 Evaluation of Learning impact of EdMuse methodology
Andreanna Koufou

13:00 LUNCH

EdMuse International Conference

14:00 WELCOME
Chair *Cristina Ferrão*

14:00 The School museum for an educational pathway: the experience of Università del Molise
Rossella Andreassi
14:20 I READ AND INVENT – animated and interactive readings to rediscover classics for early childhood through play improvisation and technology
Sara Borrelli
14:40 Education through co-creation: the proposal of Participatory Museum by the MuVeRe network
Chiara Marin
15:00 Technoscience as heritage in the classroom
Laila Zwisler
15:20 The collections of the Italian University Museums Network for an education to scientific method with new technologies
Elena Corradini, Emiro Endrighi

15:40 COFFEE BREAK

Idea Galleries
Chair Andreanna Koufu

16:00 Academic Heritage as a tool for the development of future scientific careers
Isabel GarcÍa Fernandez, Maria Eugenia Blazquez, Daniel Rivera
16:10 Digitization of museum specimens and development of novel tools in biology course *Jacopo Vizioli, Catherine Delbende, Albin Pourtier, Bernard Mikolajczyk, Bernard Deleplanque, Pierre-Eric Sautière*
16:20 The cultural heritage to improve skills and to create a bridge between school and museum
Marina Andrea Colizzi, Maria Grazia Camerota, Ralf JoshuaTrillana Sales, Vincenza Ferrara
16:30 Why can Flipped Learning experience be so meaningful, in relationship with cultural and museum heritage?
Maurizio Maglioni, Daniela Di Donato
16:40 Western influences in medieval Macedonian art, Museal and Educational context
Snezhana Filipova
16:50 Artec Campus
Elena Lah, Elena Monfalcone, Beatrice Cesarano
17:00 Supporting the Network. Innovative approaches to Heritage Education
Marina Di Berardo

TUESDAY 27 JUNE

Chair Piedade Vaz Rebelo

9:30 Explore, Think and talk about art, to better understand the world
Montserrat Morales
9:50 Making Prehistory More Accessible with Digital Heritage — The Use of 3D Technologies in Museum Exhibition and Education
Stance Hurst, Jessica Stepp, Susan Rowe, Eileen Johnson
10:10 Archaeological museums as environments of informal and non-formal science and technological education:
The case of Educative Islands
Popi Georgopoulou, Dimitrios Koliopoulos

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10:30 COMIC TIMELINE: Heritage Comic Hub, an inspired cultural network based on creativity via Cultural Heritage @Archaeological Museum of Patras *Georgia Manolopoulou, Yanna Papadopoulou, Andreanna Koufou*

10:50 COFFEE BREAK

11:15 Round Table and discussion
with experts of museums and education coordinated by Cinzia Dal Maso: Irene Baldriga (ANISA President and Director of Virgilio High School in Rome), Rossella Caffo (MICHAEL Culture Association president), Susanna Occorsio (MiBACT, DG Research), Fabrizio Cobis (MIUR, DG Coordination and Development of *Research)*, Monica di Gregorio (president of the scientific committee of Museumgrandtour), Valeria Pica (ICOM Italy coordinator of the education and mediation commission)

12:45 Conclusions and future perspectives

13:00 LUNCH

14:00 The DICHE Workshop. Digital Innovation in Cultural and Heritage Education
Antonella Poce, Francesco Agrusti, Maria Rosaria Re

16.00 END OF CONFERENCE

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TABLE OF CONTENT

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Posters of multimedia lesson made by teachers involved in the EdMuse Project

Funded by the Erasmus+ Programme of the European Union

Weather

Maria Ampla
Primary School Teacher

Lesson unit: **Weather**

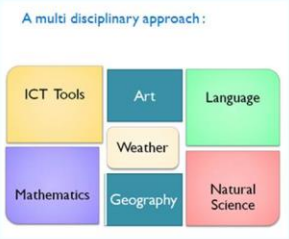
- Grade: 3rd, 8 years old
- Number of students: 20 students (9 boys and 11 girls), control class: 20 students (10 boys and 10 girls)

Aims:

- raise cultural awareness
- empower students to gain knowledge and skills by active involvement in creating and producing their own context
- promote inquiry based and problem solving learning
- allow independence and ownership over students' learning
- foster their ability to negotiate
- assist students develop soft skills (presentation, collaborative work)
- rearranging physical space
- come across new careers

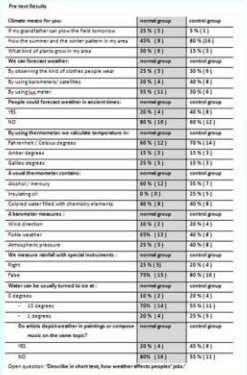
Method

- Same pre and post tests were provided for both classes (questions: 6 multiple choice, 2 yes/no, 1 False/ Right, 1 open question)
- Students worked in groups of 5
- Multi-disciplinary approach
- Constructivism
- Constructive controversy theory
- Experimental approach with authentic learning (with use of experimental supplies of everyday life)
- Peer instruction
- Collaborative learning (for example with use of ICT Tools)



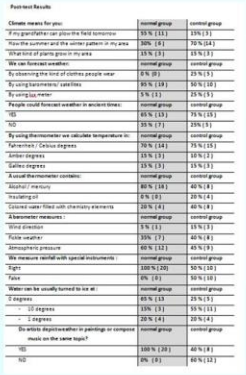
Results and Conclusions

- Although students are experiencing weather changes in everyday life, have difficulties on understanding the connection between weather and environment and usually confuse the terms of weather and climate.
- **Pre – test questions** confirm the difficulties both group of students have on understanding the relevance of weather and environment as also the confusion of the terms weather and climate (climate means for you: wrong answers 75% normal group, 95% control group).
- The multi-disciplinary way of teaching, the use of cultural heritage as also of the experiments clearly helped the students of the normal group in contrast to control group, to understand deeper even difficult topics of weather (even the difficult discrimination of weather and climate +30%).
- There is also impressive improvement even at more technical questions (a barometer measures atmospheric pressure + 35%) as also at the reference of so many professions affected by weather change.
- The students were excited to use all these different materials and participate to experiments and engaging/integrated activities that lead to a multi-sensory meaningful experience and to growth.



Pre-test Results		
Climate means for you:	normal group	control group
If my grandfather can plow the field tomorrow	25 % (5)	5 % (1)
How the summer and the winter pattern in my area	45% (9)	80 % (16)
What kind of plants grow in my area	30 % (6)	15 % (3)
We can forecast weather:	normal group	control group
By observing the kind of clothes people wear	25 % (5)	10 % (2)
By using barometers/ satellites	20 % (4)	40 % (8)
By using ice meter	55 % (11)	30 % (6)
People could forecast weather in ancient times:	normal group	control group
YES	20 % (4)	40 % (8)
NO	80 % (16)	60 % (12)
By using thermometer we calculate temperature in:	normal group	control group
Fahrenheit / Celsius degrees	60 % (12)	70 % (14)
Amber degrees	15 % (3)	15 % (3)
Gallieo degrees	25 % (5)	15 % (3)
A usual thermometer contains:	normal group	control group
Alcohol / mercury	60 % (12)	35 % (7)
Insulating oil	0 % (0)	25 % (5)
Colored water filled with chemistry elements	40 % (8)	40 % (8)
A barometer measures :	normal group	control group
Wind direction	10 % (2)	20 % (4)
Fickle weather	65% (13)	40 % (8)
Atmospheric pressure	25 % (5)	40 % (8)
We measure rainfall with special instruments :	normal group	control group
Right	25 % (5)	20 % (4)
False	75% (15)	80 % (16)
Water can be usually turned to ice at :	normal group	control group
0 degrees	10 % (2)	20 % (4)
- 10 degrees	70% (14)	55 % (11)
- 1 degrees	20 % (4)	25 % (5)
Do artists depict weather in paintings or compose music on the same topic?	normal group	control group
YES	20 % (4)	45 % (9)
NO	80% (16)	55 % (11)

Open question: 'Describe in short text, how weather affects peoples' jobs.'



Post-test Results		
Climate means for you:	normal group	control group
If my grandfather can plow the field tomorrow	55 % (11)	15% (3)
How the summer and the winter pattern in my area	30% (6)	70 % (14)
What kind of plants grow in my area	15 % (3)	15 % (3)
We can forecast weather:	normal group	control group
By observing the kind of clothes people wear	0 % (0)	25 % (5)
By using barometers/ satellites	50 % (10)	50 % (10)
By using ice meter	5 % (1)	25 % (5)
People could forecast weather in ancient times:	normal group	control group
YES	85 % (17)	75 % (15)
NO	15 % (3)	25% (5)
By using thermometer we calculate temperature in:	normal group	control group
Fahrenheit / Celsius degrees	70 % (14)	75 % (15)
Amber degrees	15 % (3)	10 % (2)
Gallieo degrees	15 % (3)	15 % (3)
A usual thermometer contains:	normal group	control group
Alcohol / mercury	80 % (16)	40 % (8)
Insulating oil	0 % (0)	20 % (4)
Colored water filled with chemistry elements	20 % (4)	40 % (8)
A barometer measures :	normal group	control group
Wind direction	5 % (1)	15 % (3)
Fickle weather	35% (7)	40 % (8)
Atmospheric pressure	60 % (12)	45 % (9)
We measure rainfall with special instruments :	normal group	control group
Right	100 % (20)	50 % (10)
False	0% (0)	50 % (10)
Water can be usually turned to ice at :	normal group	control group
0 degrees	65 % (13)	25 % (5)
- 10 degrees	10% (2)	55 % (11)
- 1 degrees	20 % (4)	20 % (4)
Do artists depict weather in paintings or compose music on the same topic?	normal group	control group
YES	100 % (20)	40 % (8)
NO	0% (0)	60 % (12)

Photos



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Fair Weather's
Greek saying (Του καλού καιρού)

Maria Angelakopoulou
Teacher of elemantary school

Purpose:
- Research of different mental representations between students about the weather and weather phenomena. Specifically, the connection between the weather and the mythology, the civilization, the temperature, the forecast, the weather phenomena and the daily life.
- Didactical interventions with the use of two different didactic methods on different didactical samples.
- Surveying knowledge that has been gained with the use of pre-test and evaluating the method.

For the achievement of the objective were scheduled:
- Two three-hour educational interventions
- Two different didactic methods (traditional and innovative)

- The traditional method has been applied on the third grade of elementary school (9 years old, 20 students).
- The innovative method has been applied on the fourth grade of elementary school (10 years old, 10 students).

- 2nd Primary School of Akrata, Achaia, Greece

➢ Cross-thematic integration :

Method (in bullets as shown below)

- Pre tests and post tests questionaires.
- Innovative education
- Cross-thematic integration : The effect accomplished by reclaiming the lessons of Greek language, Study of Environment, Physics, History, Fine arts, Music, ICT
- Didactic method: Project Artful Thinking (Perkins, 1994)
- 5 artworks were selected whose subjects covers the connection between the weather, weather phenomena and the reflect of the weather itself on the daily life of people
- Students were separated in two teams. After observing an artwork from the above and following specific steps they answered the same questions and filled the worksheets we gave them.
- 1st stage: Simple observation
- 2nd stage : Creative observation
- 3rd stage: Detailed observation
- 4th stage: Holistic observation
- Traditional teaching
- Brainstorming method
- The students constructed their own weather calendar about the four seasons and how they interact with the temperature and the weather phenomena.
- They referred on the interaction between the weather and the civilization, the art, the mythology, the calculating of the weather phenomena and their connection with the daily life.

Results and Conclusions (in bullets and tables as shown below)

From the results we can consume that the innovative education had positive affection on students' knowledge about the weather. It changed students wrong opinions about the weather phenomena. On the other hand, the traditional education didn't affect the results. Students still have wrong opinions about the weather. However, the percentage of the students who still have wrong opinions about the weather is lower than the expectable amount, if we consider that the traditional method was used. This is a result of the very high cognitive level that third grade's students of this specific school have.

Post-test questionnaires innovative teaching Vs Post-test questionnaires traditional teaching

	83,3%
	83,3%
	100%
	41,7%
	58,3%
	33,3%
	91,7%
	75%
	100%
	15/20 (open type question)

Photos

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"Our solar system"

Gantzoudi Stavroula , *Primary School Teacher*, Theofanis Valmas, *School Counsellor*

SUMMARY

The project that was presented is called "The Solar system". It is part of the school lesson "We and the World" of the 6th grade, a lesson about a general view of the world, plants, animals, environment, water and energy, etc. In this grade students don't have a specific unit about space. This was the reason the certain topic was chosen. Our goal was to teach children about the space and especially about our solar system, the planets that orbit around the sun and their characteristics. Moreover, our target was to discover the students' previous knowledge about sun, planets and their position in the solar system, connect the new with the previous Knowledge and distort their misunderstandings. In addition, our intention was to combine planets with art and the ancient world gods, that gave the name on the planets. We intended to see if the students realize the relationship and the connection between the name of the planets and the ancient Greek and Roman Gods. Furthermore, the second part of this lesson refers to the ways we observe the sky, to the scientists of the sky, astronomers, and their instruments, telescopes.

Moreover, we delivered the subject in a cross-curriculum approach, connecting science and planets specifically, with Maths, Language, Technology, Art, Greek and Roman Mythology and History (Aristarchus, Galileo and Copernicus). Our main purpose was to teach science in conjunction with museum education. In this case, we have used the Europeana collection and the Edmuse platform in order to get information and data about sculptures, pictures, books, paintings and other work of arts, from exhibits of art museum.

Finally, pre and post tests were given to both classes, data was analyzed and conclusions were extracted. The conclusions revealed the serious contribution of the platform to the construction of the new Knowledge, showing the major impact of the initial task. Through this approach our goals were fulfilled, students in the main class did very well to the post lesson evaluation, and it became obvious that they managed to construct knowledge and create a positive attitude towards learning.

Theoretical background

This unit refers to our planet, to our universe. Learning about space is a very important knowledge, and students need to be introduced in the planetary research and familiarize with the planets and their features as they have a lot of inquires, misunderstandings and questions about. Also, this subject is important because it responds to the interests and the curiosity of the students, as they showed a great interest about space and the other bodies around, such as dwarf planets, comets, meteorites, our galaxy in general.

Furthermore, given the fact that students have previous knowledge, coming from their experience from school, TV, their social environment, as it was revealed with the brainstorming technique, it is important to check this knowledge and the misunderstanding that it is certain that exists. On the other hand man, even from the prehistoric period, always wanted to learn about the stars and the univers, myths were created to answer to this need and to feed his imagination. So, in general, the theme responds to the internal human need for understanding and exploration.

Finally, given this absence of a planets' unit in the curriculum, and trying to fulfill this "gap", we choose this topic with the expectation that the students will respond with a great interest.

Basic information of the subject

In order to know how the use of digital resources of heritage cultural (Europeana collections) and the EdMuse platform contributes in the construction of knowledge and the development of students we delivered the same lesson in two different classes, the experimental and the control class. The experimental class used the EdMuse platform and in a multidisciplinary approach. The experimental class is 4th grade, (10 years old), a group of 12 students. Their knowledge about planets for both classes is very limited and based on their experience, they have never taught about planets, but they have a good knowledge of ancient Greek and Roman mythology and gods. In order to compare the results, we delivered the same lesson to the second class, the control class, following the usual traditional methodology, without make use of the platform. This class consists of 14 students, of the same age and grade and approximately the same educational level with the main class. The goal of the comparison is to define if children construct knowledge through our teaching and if there are differences or no in the construction process of the main and the control class. Worksheets and activities took place to both class and are demonstrated below.

Also, pre and post test was given to both classes, data was analyzed and conclusion was made. The conclusions revealed the serious contribution of the platform to the construction of the new Knowledge, and gave as severe conclusions of how important the task is. Through this approach our goals were fulfilled, student in the experimental class did very well to the post lesson evaluation, and it became obvious that they managed to construct knowledge and create a positive attitude towards learning.

Learning objectives

- To learn about the eight planets and their unique and identified features (e.g. size, distance from earth, sun etc.)
- To build the model of the solar system and put the planets in the right order orbiting around the sun.
- To investigate the origin and the meaning of the name of the planets and correlate them with the ancient Greek and Roman myths and gods.
- To learn about telescopes and astronomers.
- To realize the macrocosm and the microcosm through the solar system.

Method

- Brainstorming technique
- Students worked in teams in a context of constructivist/sociacultural (Vygotsky, Brown) and multidisciplinary approach of learning with the use of properly designed worksheets in Language (e.g. writing a text), Mathematics (e.g. calculations of planets dimensions and diameters), Music (listening to related music pieces) and art (e.g. drawing and forming solar system).

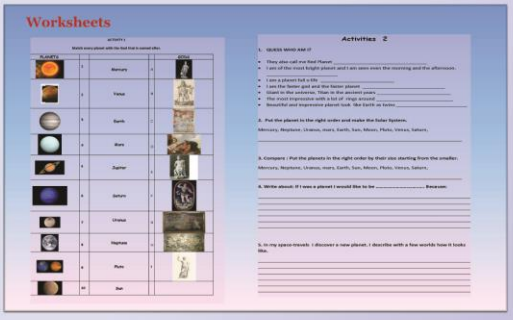
Participants

The students that participated in the project were from two 4th Grade classes (10 years old). The first class, the experimental class, had 12 students. The second class, the control, had 14 students of the same age, and the same level of knowledge about the topic. The duration of the lesson was two lesson hours (90 minutes). The lessons took place in the classroom, in the beginning of March 2017.

Procedure

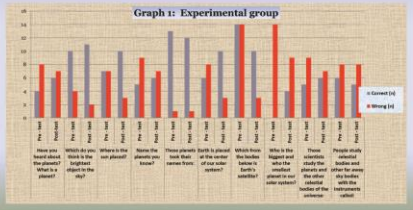
- Pre-test questionnaire was given in order to detect student's prior knowledge of the topic.
- Watching a piece of film and a simulation video of universe.
- Brainstorming about what a planet is and checking of the previous knowledge.
- Use of a power point to present information about the characteristics of each planet matching with ancient Greek and Roman gods and connect through the EdMuse platform's links to Museum work of arts.
- Learn about the first astronomers, Aristarchus, Copernicus, Galileo.
- Working in teams with worksheets.
- Make the construction of the solar system model.
- Play with card as a conclusion.
- Post-test questionnaire was given in order to detect student's knowledge of the topic.

Worksheets



Results

- In the post test questionnaire the results of the control class, were better than the ones in the pre-test, but not as good as those of the experimental class.
- There still was a difficulty for all students in expressing the definition of the planet in post test, even if it was seemed that they have understood the term.
- There was a lot of children's misunderstandings regarding the position of Earth in our solar system, as we can conclude from the answers to the post test of the control class and the experimental class as well.
- It was easier for the students of the experimental class to find the position of Earth in the planetary system and also to answer the question about the bigger and the smaller planet.
- For both there was a misunderstanding about Sun being the center of the solar system.
- Students from both classrooms knew the word telescope and had no knowledge of the astronomers.
- They had a previous knowledge for some of the planets.
- In post test it was easier for students of the experimental class to refer to the planets in relation to those of the control class.
- It became easier for the pupils of the experimental class to find the position of Earth in the planetary system and answer the questions about the bigger and the smaller planets.
- In conclusion, in the experimental class there were a lot of interest, attention, and correspondence from the pupils. It was a very stimulus and pleasant lesson, complete and creative. In the control class the lesson was less interest and not too energetic. In the experimental class students gain more information and an interest for the stars and planets, while in the control class it was just a traditional lesson with some interesting parts.



Conclusions

- In the experimental class children showed a great interest that overcome our expectations. They were very concentrated throughout the two hours. Time was not enough to deal with all the questions the students had. They gain a small but good knowledge of this subject. Seeing the topic in a multidisciplinary way, helped them to construct their knowledge through history, mythology, arts, museum, collection of arts and other exhibitions, with easy and pleasant activities.
- In the control class, it was an ordinary lesson, traditional in the approach and the tools that were used.
- The lesson was more interesting, stimulus and alive for the students of the experimental class. The pictures of planets, sculptures, other arts craft and of telescopes gave them a vivid interest and developed their curiosity and urge for learn. Students in the control class showed less interest compared with the students of the experimental class.
- Students in both classes had a fragmented knowledge about planets, a confused knowledge and misunderstandings about the position of the earth and the sun in the solar system and a difficulty to express in words a description of a planet. Finally it became easier for the students from the experimental class to put their knowledge in the right order.
- In general we believe that in the experimental class student managed to construct knowledge through the new approach in a more interesting, easy and efficient way in comparison with the control class.

Future extensions

As it was revealed students expressed their enthusiasm about the new knowledge they learned. New interesting questions were came up from students for further investigation regarding other planets, dwarf planets, satellites, etc. and about the existence of life elsewhere in the universe.

On the other hand introducing students in the use of the platform and the process of seeking information would be a future approach to construct their knowledge in a interactive, more energetic and dynamic way.

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Photos

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'WhATEveR...*forever and ever*'

By the teacher Maria Gotsopoulou

"WhATEveR... for ever and ever" is an experimental teaching which took place in the 46th Primary School of Patras, fourth grade. The students were 35 ten- year-olds. We taught about water based on multidisciplinarity. The only source of the didactic material we used was the Edmuse Platform which contains museum exhibitts of european cultural heritage. The students, while learning about water, became familiarised with the digitalised cultural heritage and the respect we must show to the source of the material we use.

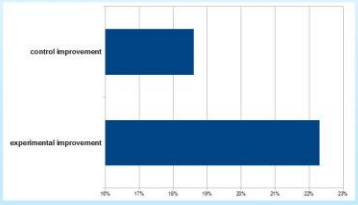
Method

- We taught in **two different classes**: the experimental and the control. The first one had 18 students, 9 girls and 9 boys while the second had 17, 9 girls and 8 boys.
- The **method** we followed was the multidsciplinary with the use of ICTs. The **topic** examined was the water through the **disciplines** of Science, Informatics and Art.
- The **didactic material** in the experimental class was exlusively from the Edmuse Platform, while the control class was taught on the basis of the one and only didactic book of Science.

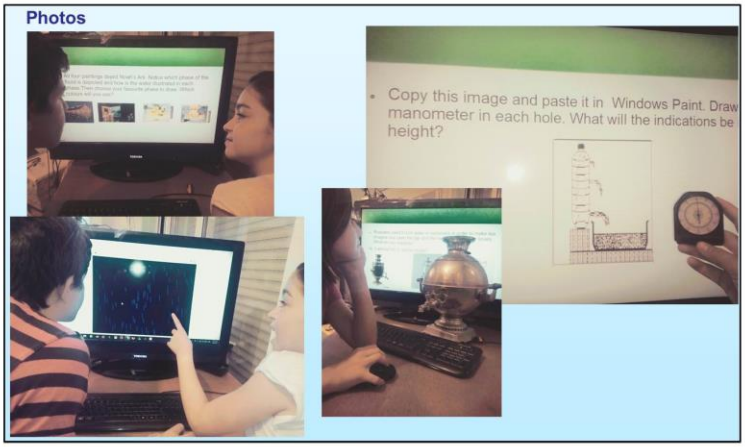
Results and Conclusions (in bullets and tables as shown below)

- Cultural heritage enriched the teaching and attracted students' attention. Moreover it gave children access to rare instruments and photos, crucial for science understanding.
- **The use of digitalised objects of cultural heritage in our teaching improved the learning outcome more than the traditional one-book orientated teaching.**

experimental pretest correct	experimental posttest correct	control pretest correct	control posttest correct	experimental improvement	control improvement
72%	88%	70%	88%	16%	18%
83%	100%	76%	94%	17%	18%
77%	94%	76%	88%	17%	12%
66%	94%	70%	94%	28%	24%
50%	83%	58%	76%	33%	18%
55%	94%	52%	94%	39%	42%
83%	100%	82%	100%	17%	18%
94%	100%	100%	100%	6%	0%
72%	94%	76%	88%	22%	12%
66%	94%	64%	88%	28%	24%



Photos



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Through the eyes of Galileo Galilei

Teacher: Olympia Papoulia
Arsakeio Primary School of Patras
Subject: Science

A total of 22 students of the 6th grade class of our school took part in the project. This project ran in March and April 2017 consisted of a didactic unit (2 hours lesson) concerning the investigation of the interaction between the telescope and astronomy with windows on the:

•scientific
•mathematical
•historical
•artistic

contribution of Galileo's discoveries. Its purpose was to increase understanding of how these discoveries are of great value to the development of the human mind and constitute, according to Albert Einstein, the dawning of science.

The students were divided in 2 groups:

•Group A ,consisted of 10 students, attended a two-hours innovative lesson following Edmuse Methodology
•Group B, consisted of 12 students attended a two-hours traditional lesson following the methodology set by the national curriculum

Method

Group A

•Pre-test questionnaire
•Experiments to be able to explain that light travels in straight lines and know that mirrors reflect light whereas lenses refract light.
•Working in groups in order to construct a timeline of the story of the telescope
•Use of digital resources (various museum objects, related photos and on line videos)
•Feedback given in 4 posters made by the students to illustrate in their own way their acquired knowledge
•Post-test questionnaire

Group B

•Pre-test questionnaire
•Experiments concerning the light and its refraction through different lenses
•Students register their results on their school books
•Post-test questionnaire

Results and Conclusions

Group A

The multidisciplinary approach helped students to:
•Know how science has advanced the technology associated with telescopes
•Realize how technological advances have improved telescopes
•Recognize how improvements in telescopes have allowed scientists to make new discoveries
•Implement more scientific terms in their vocabulary
But due to the lack of time some of them couldn't clarify the difference between a concave and a convex lens
Overall, group A students enjoyed their time during the lesson because they kept asking for another science lesson to be provided the Edmuse way

Group B students

• improved themselves in knowing better about the light and the lenses
• connected Galileo's discoveries with the need of people to see better in their everyday life (for example help myopic people enlarge letters

As can be seen from the results of this research to acquire skills to organize science lessons based on digital resources of museums can be of great value to both teachers and students.

QUESTIONS The 1st column in post test refers to group A and the second one to group B			Correct (n)	Wrong did n't know (n)
Q1	What is the object shown below?	Pre - test	11	11
		Post-test	10 8	0 3
Q2	Choose the person who first used the telescope in order to do astronomical observations. • Aristotle • Galileo Galilei • Christopher Columbus	Pre - test	18	4
		Post - test	10 10	0 2
Q3	Choose the correct answer. the light spreads..... • in cycle • in straight lines • at an angle	Pre - test	18	4
		Post - test	10 12	0 0
Q4	Choose the correct answer. a lense is a/an ..... object • semi-transparent • non-transparent • transparent	Pre - test	10	12
		Post - test	8 8	2 4
Q5	The lens you see in the picture below is ..... • a convex lens • a concave lens	Pre - test	12	10
		Post - test	7 10	3 2
Q6	The lens you see in the picture below is ..... • a convex lens • a concave lens	Pre - test	11	11
		Post - test	7 10	3 2
Q7	The light is reflected when it encounters..... • fabric • a mirror	Pre - test	22	0
		Post - test	10 11	0 1
Q8	The light is refracted when it enters.... • a lens • black paper	Pre - test	5	17
		Post - test	5 7	5 5
Q9	In order to construct a telescope we can use ..... • lenses • mirrors • both	Pre - test	5	17
		Post - test	7 9	3 3
Q10	In what way do you think the telescope of Galileo changed the beliefs of people about the universe?	Pre - test		
		Post - test		

A summary of the answers in question 10 is given below :
Pre test
A. Using the telescope people could have a better view of:
The sky
The planets
The moon
The castles of the enemy
The solar system
B. The telescope helped people
To see better the objects that were far away
To understand that the earth is moving, not the sun
To observe what is worth seeing from far away
To know if they could live in another planet
To count when a meteorite will fall
In astrology
Post test
Group A (10 of the students that have been taught using neo technologies-edmuse).
The use of the telescope helped people and scientists to have a better understanding of:
The laws of nature
The planets and their positions in the universe
The sun
The space
using reasoned experimentation (the scientific way)
Group B (12 of the students that have been taught by the traditional method)
The use of the telescope helped people and scientists:
To enlarge the small letters and objects
To discover new planets and stars
To expand our knowledge about the universe
To help myopic people see better
To observe objects from a long distance
To develop a new science, astronomy.

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"Through the eyes of Galileo"

Maria Roussaki
Teacher in Primary Education

•This teaching unit with the title "***Through the eyes of Galileo***" was implemented at the Primary School of Kato Kastritsi Patras Greece .
•The number of students was 25 at the age of 11th (sixth grade).
•The topic was about the scientific discovery of telescope from Galileo Galilei and how he managed to change people beliefs about the planets and the solar system.

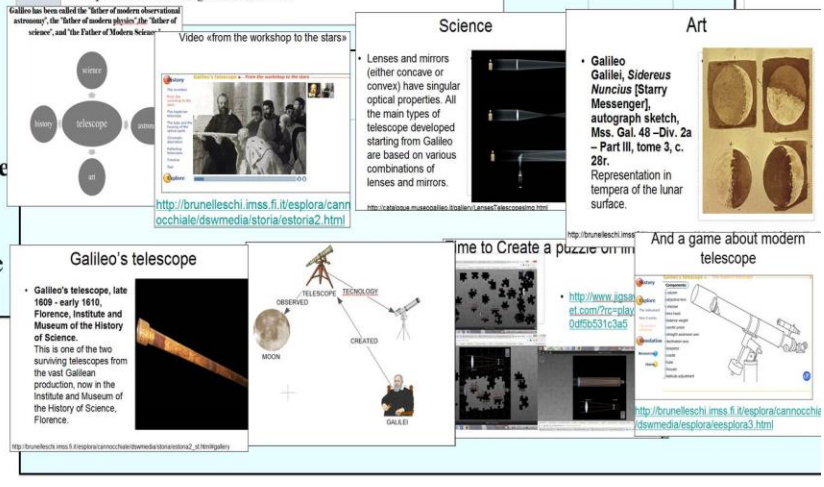
Method (in bullets as shown below)

- Our didactic goal was to enrich our student's knowledge regarding the telescope, the man who invented it and how it can be used in scientific observations.
- Furthermore to realize that thanks to the power of his instrument, Galileo achieved exceptional results in his observations of the moon, and made exceptional series of astronomical discoveries.

- The students from the beginning were divided in two groups.
- Group A, consisting of 12 students, was taught in a multitasking learning environment
  - ◆ using collaborative working
  - ◆ modern technology and
  - ◆elements of digital cultural heritage of Galileo museum in Florence .
- Group B, consisting of 13 students, was taught the same unit using the traditional way according to the student's book.
- The duration of the teaching unit was for both groups 90 minutes .
- In order to compare the results of the differences between the two groups was used a questionnaire of ten questions. In the beginning all students (both groups Aand B) answered the questionnaire (**pre –test**).
- After the teaching process groupA and groupB answered the same questionnaire (**post-test**).

The results and the conclusions that came out after data processing are presented in the chart below :

	QUESTIONS The 1st column in post test refers to group A and the second to group B		Correct (n)	Wrong/don't know (n)
Q1	What is the object shown below?	Pre - test	21	4
		Post-test	12/11	0/1
Q2	Choose the person who first used the telescope in order to do astronomical observations.	Pre - test	22	3
		Post - test	12/10	0/2
Q3	Choose the correct answer: the light spreads.....	Pre - test	22	3
		Post - test	12/11	0/1
Q4	Choose the correct answer:a lense is a/an..... object	Pre-test	18	7
		Post - test	10/9	2/3
Q5	The lense you see in the picture below is.....	Pre - test	17	8
		Post - test	12/11	0/1
Q6	The lense you see in the picture below is.....	Pre - test	17	8
		Post - test	12/10	0/2
Q7	The light is reflected when it encounters.....	Pre - test	22	3
		Post - test	12/12	0/0
Q8	The light is reflected when it enters.....	Pre - test	13	12
		Post - test	12/5	0/7
Q9	In order to construct a telescope we can use	Pre - test	2	23
		Post - test	9/4	3/8
Q10	In what way do you think the telescope of Galileo changed the beliefs of people about the universe?	Pre - test		
	A summary of the answers in question 10 is given below : **Pre test** A .Using the telescope the scientists could have a better view of: The sky The planets The moon The solar system B. The telescope helped people To see better the objects that were far away To understand that the earth is moving, not the sun To observe what is worth seeing from far away To know where the light comes from and if there is water in other planets. C. They were bored so they made it. **Post test** **Group A (the students that have been taught using new technologies-edmuse).** The use of the telescope helped scientists to have a better understanding of: The laws of nature The planets and their positions in the universe The sun The space. **Group B (the students that have been taught by the traditional method)** The use of the telescope helped scientists: To enlarge the small letters and objects To discover new planets and stars To expand our knowledge about universe	Post - test		



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Water is key to life

Maria Coleti
Primary school Teacher

I.C. Via Val Maggia- Rome_ Italy
J

General description

The project *"Education and museum: cultural heritage for Science Learning"* promotes a new technique for teaching and learning science, through an interdisciplinary methodology that uses digital resources and technologies as well as cultural references of museum platforms.
. For primary school "A. Manzi" class IV A, the subject has been : the water.

The classes involved in the project were the two fourth grades of primary school "A. Manzi": IVA class (experimental,21 students, 9 yers old) who followed the multimedial lesson and IVB class (control, 21 students, 9 years old) who followed traditional lesson.

Learning objectives

- To learn about water features.
- To learn about water use.
- To learn about the benefits of water for humans.
- To learn about the importance of water for ancient civilizations.
- - To learn about the roman bath.
- To investigate the water in Italian poems,in art, in music , in sport
- To learn about hydraulic works.

Method

The multimedial lesson has followed specific guidelines:

- interdisciplinary areas and contents

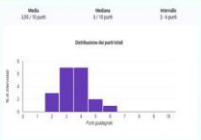
- Information have been organized in different Power Point slides. Each slide was provided by text and imagine files

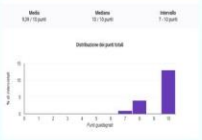
- Imagine have been taken from historical, art, science and technologic museum platforms as well as through EDMUSE: a platform suggested during the course.
- **- AS piloting/ verification** questionnaires for students, to submit before and after teaching unit. Questionnaires included ten questions: nine were multiple choice questions and one was an open question.
- **The multimedial lesson presented in the experimental class was followed with interest .**
- **After the lesson, students of experimental class did a**

the

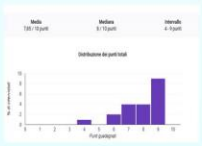
Results and conclusions

The results of the questionnaires of students of control class have showed increased learning compared to students of control group.





Experimental class



Control class

Photos

Experimental class

Experimental class

Control class

Control class

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Galileo Galilei

Lucia Italia
Teacher I.C. Via Val Maggia - Rome -Italy

General description:

- The Teaching Unit about Galileo Galilei was implemented at the middle school IC Via Val Maggia in Rome.
- The number of students involved was 15 and their age was 12.
- The topic was about Galileo Galileo
- The aim was to introduce the students to Galileo's major contributions to the fields of physics, astronomy, mathematics, italian literature and philosophy
- The project's methodology implied the use of open digital resources from the cultural heritage.

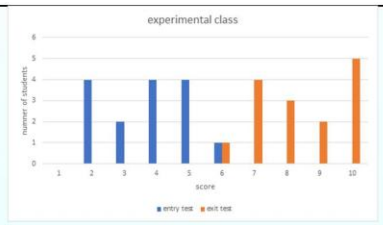
Method

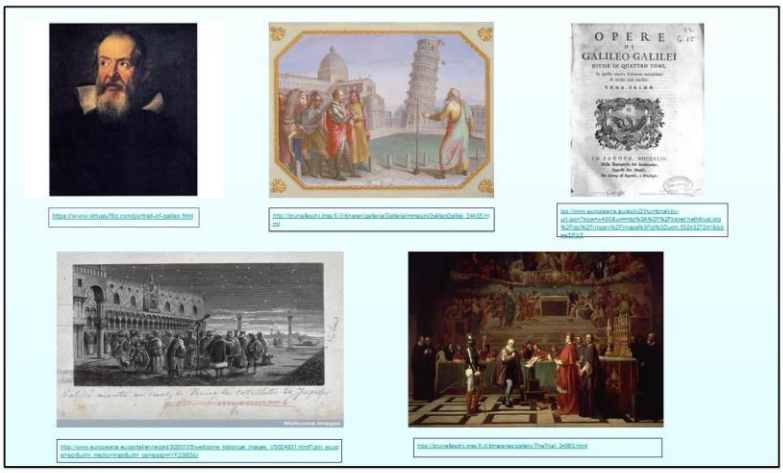
- Powerpoint presentation centrated on images taken from the EDMUSE platform and from other cultural digital resources that cultural Institutions around the world make available online.
- Multidisciplinary approach embracing the following subjects: Science, Literature, History and Art.
- Interactive approach giving the students the opportunity to interact with the teacher and with their pairs.

Assessment:

- Teacher's observation during planned activities
- Written entry and exit test submitted before and after the teaching unit
- Oral questions

Graphical representation for tests results





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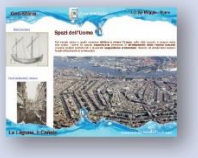
In and Out of the Water

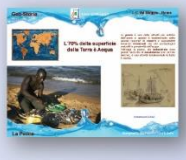
Giuseppina Licciardello, Primary School Teacher, I.C. Val Maggia, Roma

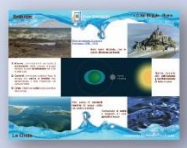
2015-1-IT02-KA201-015013

Interdisciplinary and multimedia teaching

Following the experience gained with the group and after careful investigation of the contents of the EDMUSE platform, I decided to articulate the theme assigned to me on WATER as a multimedia project, in a series of slides with sequential content that could capture the student's attention to multidisciplinary arguments but always intimately connected to one another, as different aspects of the same discourse.I have decided the title "OUT AND IN THE WATER" to emphasize the importance of "content" of "water" both in formal and substantive terms, bringing the kids to explore consciously the world of "inside" and "out" as the intimate and exterior contexts of the world we live in and the things that are part of it. The disciplines involved in the display of the topics were essentially Literature, Art, Science, Geography and History. All in a context of appreciation of the language in general (composition) and of the Italian language in particular (knowledge of the word). Obviously the EDMUSE material has been of fundamental help and stimulus in the construction of a speech also made for image-content with extensive historical references to past documents (videos, maps and works of art).



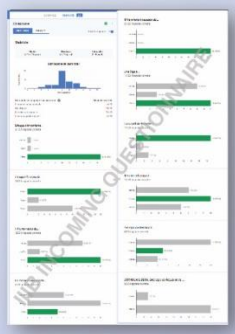


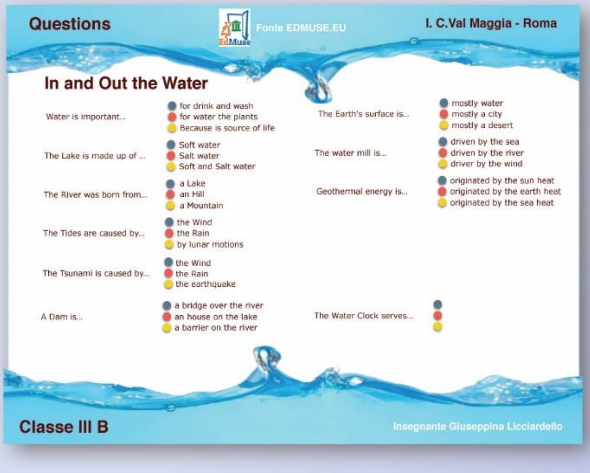


Same slide of the project

Articulation of the Multimedia Project

The graphic design wanted to take into account a consonant and colorful setting that left to the theme of the Water. After a short presentation, the sequences of the "Water Figures" like Mythology-Water stories (iconographic story) - The Sounds of Water (The Sirens) - La Fiaba; this first part captures and stimulates the artistic spirit, fantastic and creative of pupils, preparing them for the subsequent acquisition of more scientific information. The next 6 tables address the issues of interaction between man and water, fishing, agriculture, the natural and anthropic environment and the fundamental theme of energy as "unforeseen and unpredictable" content of water. We continue with the theme of Waves, Streams, Tides and Tsunami as "experimental" phenomena by the pupils and therefore subject to free discussion.
In the final part you return to art, to simple measurements of time and poetry also proposed as experience to try and repeat ... working together.





Questionnaire contents and data have been reported in GOOGLE FORM standard to uniform and analyze results.

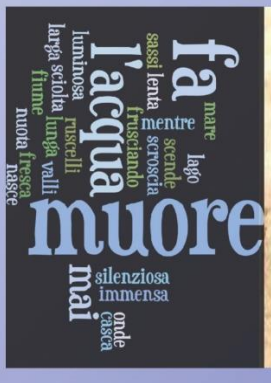
Verification method for multimedia educational project

The hypothesis of work was based on the drafting and subsequent submission of an "ad hoc" questionnaire to propose to pupils BEFORE and AFTER the teaching activity.
In order to verify the effectiveness of the MULTIMEDIA tool than the classic system of the lesson in the classroom, the same questionnaire (both in ENTRY and OUT) was proposed to a Pilot Class of the same institute with pupils of the same age who have been subjected to similar traditional thematic lessons; the topics discussed in the other class were obviously the same but in different ways and not using material from the EDMUSE platform.
From the comparison of the respective questionnaires results, it was possible to carry out very significant comparative tests described below.

An experiment with WATER CLOCK, a brief film and a Composition of Words are same of the job made in the Classroom Workshop

Comparative outcomes and on classroom activities

The students, excited about the arguments, turned out to be ready to surf the sites when school time allowed them to do so. This situation has been of great help to those children who exhibit some difficulty in concentrating and in oral exposure. Presentation through related images and supported by short texts immediately captured their attention by the synthesis of arguments and KEY WORDS specially arranged to facilitate the rapid storage of the concepts exposed.
The guys produced an absolutely excellent project, navigating on the EDMUSE platform by performing both experiments and competitive exercises, not least the work of re-publishing a poetic text.
In particular, it is worth mentioning the methodology adopted: the deductive method was used, so the image / definition made possible the expansion by going directly to the search for images, information and interdisciplinary content.
Students were also able to perform, in classroom and in group, their own lesson about the treated arguments working on specific .



Conclusions

The children, in reference to my request (last slide) to write a text with words in a scattered order, worked together at school, consulted each other they made out concordant phrases whose meaning was consistent with the birth of the river until he died in the sea " Without really dying ".
I wanted to consider this text as representative of a metaphorical path that had its course, but ended up but is ready for a new start.
Repeating this experience is what I hope for the future.

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The Solar System

Cristina Maria Lonetti
Primary school Teacher
I.C. Via Val Maggia – Rome - Italy

General description

The objectives of this project were to develop an interdisciplinary thematic unit plan on our solar system. Our solar system has many teaching materials and shows many educational opportunities. It is also a topic in which different areas of study can be integrated, keeping students interested and involved. Our planets are very interesting and offer many questions that can bring children to form their own opinion and to use critical thinking.

The classes involved in the project were the two fifth grades of primary school "A. Manzi ": VA class (experimental class – 23 students, 10 years old), who followed the multimedia lesson and VB class (control class - 24 students, 10 years old), who followed a traditional lesson on the same subject.

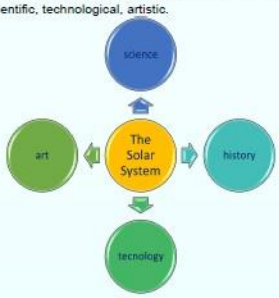
Learning objectives

- ✓ To learn about the geocentric and heliocentric theory.
- ✓ To learn about the first astronomical tools.
- ✓ To learn about telescope and astronomers (Copernico, Galileo).
- ✓ To learn about the planets and their unique and identified features (e.g. size, distance from earth, sun etc.)
- ✓ To investigate the origin and the meaning of the name of the planets and correlate them with the ancient Greek and Roman myths and gods.
- ✓ To learn about some examples of works of art and poems related to the solar system.
- ✓ To build a model of the solar system and put the planets in the right order orbiting around the sun.

Method

The multimedia lesson has followed specific guidelines:

- ✓ Hypertext was created using multimedia tools and new approaches to scientific disciplines, highlighting the multidisciplinary aspects of the established topic, incorporating resources related to cultural and museum heritage.
- ✓ The necessary resources have been searched on museum platforms, particularly on the EdMuse platform.
- ✓ In the developed hypertext, different disciplines have been transversally integrated and different skills have been included that ranged from linguistic to historical, scientific, technological, artistic.



- ✓ As piloting/verification tools, a questionnaire was created, consisting of ten questions, one open and nine of multiple choice, related to the chosen topic, to monitor the learning processes.

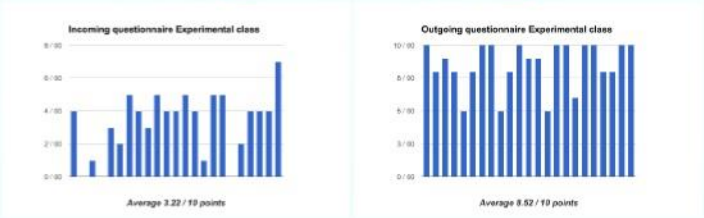
The questionnaires was administreted in two times: before and after the Learning unit is carried out, in both classes involved.
By administration of the initial questionnaire occur the basic knowledge, all the information that the student possesses independently the school that are the result of input and stimuli that he receives from his family and the social and environmental context in which he lives, the so-called "cultural baggage."
The final verification questionnaire will assess the abilities and skills acquired by the students and will reflect the degree of learning achieved as a result of multimedia lessons (comparing pre / post within the class).
The multimedia lesson presented in the experimental class was followed with great interest and curiosity.
Probably the thing that kept the attention of the pupils was the unexpected connection of a purely scientific topic to museums-historical images concerning non-scientific disciplines.
The resources from our heritage used in the construction of hypertext have revealed a great potential for information regarding physical and material characteristics, geographic location, relationship with different study disciplines.
So the museum object, used as an image associated with a concept, has been particularly useful for those pupils with cognitive, behavioral or attention deficit.
After the presentation of the lesson, students of sperimental class did a research on the same subject, using the same system for realizing relationships, associating theoretical knowledge with the experience of the objects.

Results and Conclusions

The results of the questionnaires of students who have used the technology approach have showed increased learning compared to students of control group.
These results have been entered and processed in google form.

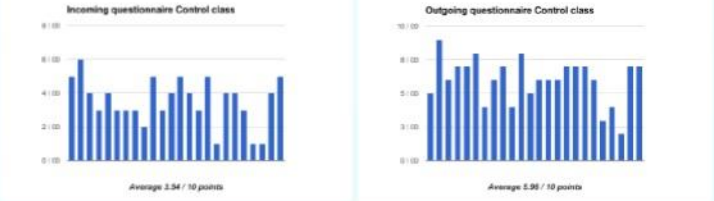
Experimental Class

from an average of 3.22/10 ⇨ to an average of 8.52/10



Control Class

from an average of 3.54/10 ⇨ to an average of 5.96/10



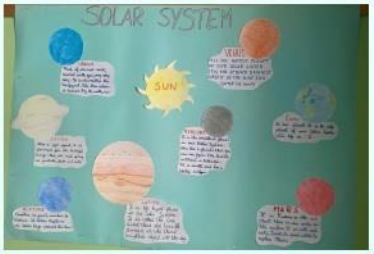
Photos

Experimental class

Experimental class

Experimental class

Control class



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Unit title

The planets

Fiorentino Sarro
Teacher of Technology in Lower Secundary School

General description

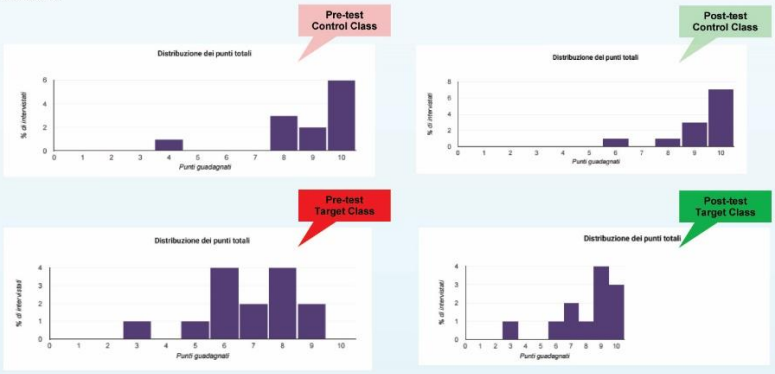
- This teaching unit, with the title "The planets", was implemented in the Lower Secundary School "IC Via Val Maggia" in Rome Italy.
- The number of students involved was 15 for target class and 14 for control class.
- They was 11 years old and they was in the the first year of Lower Secundary School.
- The lesson was about astronomy and explained to students how the solar system is made and what are the planets that make it.
- They was used technologies, open digital resources and non-formal contents for the improvement science learning.
- Two tests were used: before the lessons was delivered pre-test and after the lessons was delivered post-test.
- Finally, the test results were analyzed in detail to make inferences about expected learning outcomes.

Method

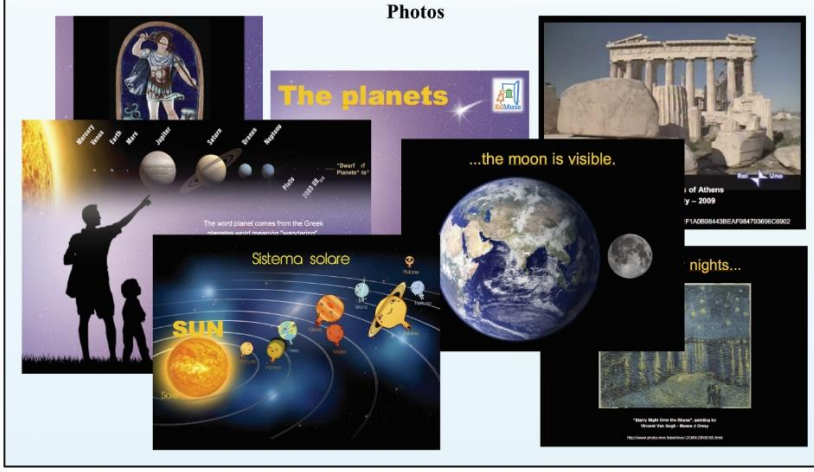
- The project is connect to the promotion of initiatives for using ICT, the open educational resources and digital resources of cultural heritage for the improvement science learning.
- The project predicted a trial phase based on the methodology illustrated at the January 2017 meeting at Digilab at the University of La Sapienza in Rome.
- The project has foreseen the involvement of two parallel and equal classes: the target class where the lesson developed according to the new methodology; the control class where the lesson was delivered according to the traditional way.
- Two questionnaires were created: one for the pre-lesson phase and one for the post-lesson phase, both for the target class and the control class.
- The final date-entry on Google Form enabled a slim and effective analysis of the final results and expected learning outcomes.
- Progress in target class learning, thanks to the EdMuse project methodology, is significantly higher, both in individual results and in overall results.
- This opportunity allowed the target class, the disadvantaged party, to retrieve and approach the learning outcomes of the control class.

Results and Conclusions

The results and the conclusions that came out after data processing are presented in the chart below :



Photos



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Funded by the Erasmus+ Programme of the European Union

Galileo Galilei

Alessandra Vallosio

Galileo: his point of view

- ✓ This teaching unit with the title "Galileo Galilei" was implemented for a 2° year class of Secondary School I.C. Via Val Maggia – Rome - Italy.
- ✓ The number of students was 20
- ✓ The medium age was 12
- ✓ The topic was about the scientific activity of Galileo Galilei as philosopher, astronomer and mathematician, the job he did to change people beliefs about the Universe and the consequences of his new approach to science.

Method

- All carried out activities have been aimed to verify if the use of new information and communication technologies and digital resources facilitates learning for primary and secondary school pupils.
- So, I tried to include as many open source resources as possible in the didactic planning, enriching my lessons with images and videos, always declaring the source and reference.
- I selected the didactic unit about Galileo Galilei and I proposed my lesson to 12-year-old pupils second year of secondary school / middle school.
- After preparing a multimedia lesson using Power Point (then converted to video format to make it more enjoyable), I prepared the pre-test to determine the real knowledge for each student.
- The lesson was presented to the class on March 14 and 15, 2017. The attention and interest of the learners were quite satisfying: many questions were asked and several times were required to stop or review the videos to better understand the meaning. Also for the teacher, the lesson proved to be stimulating, as it was very interactive. Among other things, there was a question about image captions, whose links enabled direct access to the proposed resource, to know the space-time location, the author, and all the information needed for further investigation.
- After the lesson I administered a final test.
- The pre-test and the final test were administered through a further innovative approach: using the "Quizziz" open source software. This instrument, known by the teacher, but not by the students at the time of the test, has made the class even more receptive, stimulating the attention and curiosity towards the new instrument and the content of the test itself.

Results

The pre-test handed out on March 8, 2017 and the data analysis suggests that:

- the students were 20, including 1 pupil with different abilities, 3 pupils with specific learning disabilities and 1 foreign pupil;
- the percentage of correct answers was 58%;
- the best performer has 90% of correct answers;
- the least performers has 20% of correct answers (they are students with specific learning disabilities);
- questions with the highest number of correct answers are about the language in which Galileo wrote and about the subject in which students will study Galileo;
- Question with the lowest number of correct answers is about the method that Galileo used to calculate the lunar mountains height.

The final test was administered on March 21, 2017 and the data analysis suggests that:

- the pupils were 20, including 1 pupil with different abilities, 3 pupils with specific learning disabilities and 1 foreign pupil;
- the percentage of correct replies was 77%;
- the best performer has 100% of correct answers;
- the least performers has 30% of correct answers (they are pupils with specific learning disabilities);
- 2 questions received 100% correct answers: both are about Galileo's trial (I suppose to point out interest in the historical aspects of the subject);
- question that received the lowest number of correct answers is about the period in which Galileo lived.

Comparison between the results of the pre-test and the final test provides clear and unambiguous evidence, summed up in the following three points:

- the contents have been correctly assimilated by pupils;
- also pupils with Special Educational Needs have improved their performances;
- the attention to Galileo's life and the "subversive" character of his discoveries intrigued the pupils.

In the control class (same school institution, same school complex, same course year, average results of pupils comparable to those of the sample class) work was done by a colleague respecting the same timing.

The lesson was of a dialog type, but no media. The tools used were the following:

- photocopies produced by teacher;
- "traditional" chalkboard with colored chalk;
- images printed in A3 format.

The pre-tests provided completely comparable data:

- the pupils present were 22, including 1 pupil with different abilities, 4 pupils with specific learning disabilities and 1 foreign pupil;
- the percentage of correct replies was 52%;
- the best performer has 90% of correct answers;
- the least performers has 20% of correct answers (they are pupils with specific learning disabilities);
- questions with the highest number of correct answers are: "Who Galileo was? A poet and a writer or a scientist and a writer or a philosopher and a poet" and about telescope;
- question with the lowest number of correct answers is about the method that Galileo used to calculate the lunar mountains height.

Data analysis of the final test have a peculiar relevance in relation to the project goal:

- the pupils present were 21, including 1 pupil with different abilities, 3 pupils with specific learning disabilities and 1 foreign pupil;
- the percentage of correct replies was 63%;
- the best performer has 100% of correct answers;
- the least performers has 20% of correct answers (they are pupils with specific learning disabilities);
- no question has got 100% of correct answers;
- question with the highest number of correct answers is about telescope (as in pre-test): telescope aroused student's curiosity;
- question that received the lowest number of correct answers is about the period in which Galileo lived.

Conclusion

Undoubtedly, interactive media teaching using multimedia media better responds to the target audience's needs, as it is closer to their natural learning methods. We cannot, in fact, be ignorant of the fact that they are digital natives.

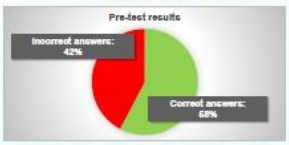
It should also be noted that it is not uncommon for digital natives to be able to process digital products of a certain level. For this reason, too, they appreciate "instinctively" the teacher who has a digital culture superior to them.

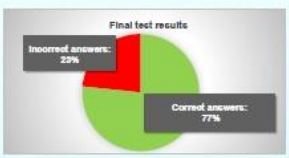
However, the multimedia product that has been utilized incorporates "traditional" knowledge that still succeeds, if appropriately proposed, to engage and fascinate the pupils.

In an expression, one might say that when we melt in a proper way "new and old", the best results can be obtained, even in science teaching.

Images

Experimental Class





Control Class

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Unit title

"Through the eyes of Galileo Galilei"

Massimiliano Veneri
Teacher of Science in Lower Secundary School

General description

- This teaching unit, with the title "Through the eyes of Galileo Galilei" was implemented in the Lower Secundary School "IC Via Val Maggia" in Rome Italy.
- The number of students involved was 22 for target class and 17 for control class.
- They was 12 years old and they was in the the second year of Lower Secundary School.
- The topic was about the Astronomical observations of Galileo Galilei.
- The aim is to stimulate the interaction between the cultural heritage about Galileo Galilei and our lives by linking scientific development to historical development and the stimulation of interest and curiosity towards the main problems related to astronomy, both in the scientific and technological fields.
- They was used digital resources related to cultural heritage about Galileo Galilei
- Two tests were used: before the lessons was delivered pre-test and after the lessons was delivered post-test.
- Finally, the test results were analyzed in detail to make inferences about expected learning outcomes.

Method

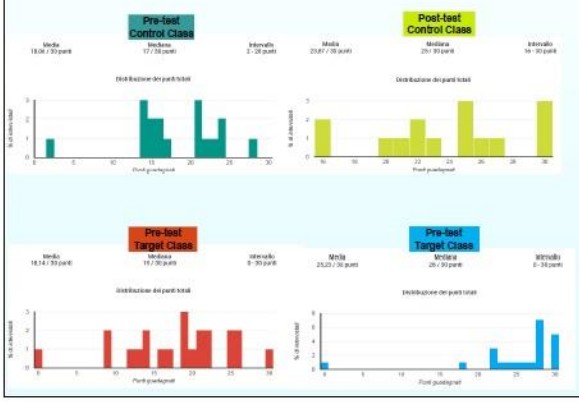
- The teaching unit was specially designed to be accessible to pupils
- The didactic unit was performed using the PowerPoint program
- The contents of the teaching unit have been selected using the EDMUSE platform, the site of the Galileo Museum in Florence and the Wikisource site.
- In order to contextualize the historical picture in which Galileo's work is framed, I used paintings and lithographs of the time, while maintaining the correctness of bibliographic references.
- To link Galileo's scientific progress to the historical and technological development of his time, I used Galileo's writings directly, taking care in the choices of the pages of his works that would allow a direct understanding of the concepts displayed through his words and drawings.
- To reconstruct how scientific innovation fits into the cultural context of the era I have included in the teaching unit references to the beliefs and superstitions of the time and to the technological and cognitive tools used to contest them
- The project has foreseen the involvement of two parallel and equal classes: the target class where the lesson developed according to the methodology; the control class where the lesson was based on the same topics but delivered according to the traditional way.
- Two questionnaires were created: one for the pre-lesson phase and one for the post-lesson phase, both for the target class and the control class.

Results and Conclusions

Processing of input and output test data on target class and control class showed an improvement in the mean of results both after the multimedia lesson in the target class and after the traditional lesson in the control class. In the target class, the average increase was 24% while in the control class it was 19%. These data, though not statistically relevant, allow me to make some reflections: the use of our cultural heritage digital content facilitates the learning of scientific disciplines. This facilitation occurs both when these digital content is presented in a traditional way or when presented through multimedia tools. The use of this tool while presenting content facilitates learning further as it allows the use of images, movies, audio, and allows for easier sharing of material with students and colleagues.

I think the efficacy of the method is above all in the didactic choice to use direct sources which allowed a certain scientific progress. This is possible only thanks to Information Technologies (I.T.) tools which guarantee teachers and students the chance to use this cultural heritage simply and independently. The direct use of sources within one's own cultural context makes it possible to deal with the conceptual issues that hinder the understanding of a scientific paradigm inside the community which generated it. These conceptual issues are very often the same that our students can not dissolve while learning the sciences. The opportunity to retrace the stages that led to the assertion of scientific progress using the original texts, the images of the society of the time, the scientific instruments used, the collected samples, etc. It is a source of unmatched long-term learning.

Results



Photos

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Funded by the Erasmus+ Programme of the European Union

Through the eyes of Galileo: lenses for a telescope
Use of rocks and minerals in the manufacture of lenses

Maria Azevedo
Escola Básica António Gedeão, Portugal

General description

Unit: Exploration of the lithological resources
Grade: 7th grade
Number of students: 31 students on the control class (7th D) and 29 students in the main class (7th B)
Age: 12 years old
Learning objectives
General objective / Descriptors
Understand that lithological formations in Portugal should be explored in a sustainable way.
- Refer applications of rocks in society.
- Recognize the rocks used in some human artefacts, buildings, arts and science objects.

Method

BRIEF DESCRIPTION OF THE INTERVENTION OF EDMUSE IN CLASSROOMS OF THE 7TH B 'EdMuseCLASS' AND 7TH D 'CONTROL CLASS' SCHOOLS

Background: In 2015, the students of António Gedeão School had practical classes using the microscope and magnifying glasses. In June 2016, a solar observing with telescopes was conducted with the support of NUCLIO. In November, an exhibition and sale of rocks and minerals was organized at the school, for all the students. In January, 2017, observation of uses of rocks and minerals, by the ancient Egyptians and Romans, in the **National Museum of Archaeology**, in Lisbon. The visit was organized by the Rita Rego teacher of the discipline of History. The students from the 7th B «EdMuse Class» were offered small samples of pumice stone and milky quartz.

7th D «Control Class»
April 27th
In a Music class, for about 15 minutes, the students answered the questionnaire.
May 2nd
In a Physical Education class, for about 15 minutes, the students answered the questionnaire.

7th B «EdMuse Class»
In between 26th and 28th of April
Application of the questionnaires for the students about the "EdMuse learning object".
April 28th
In the Natural Science class, before presenting the "EdMuse learning object", the students were questioned:
What are the applications of rocks and minerals?
What is the importance of rocks as a natural resource?

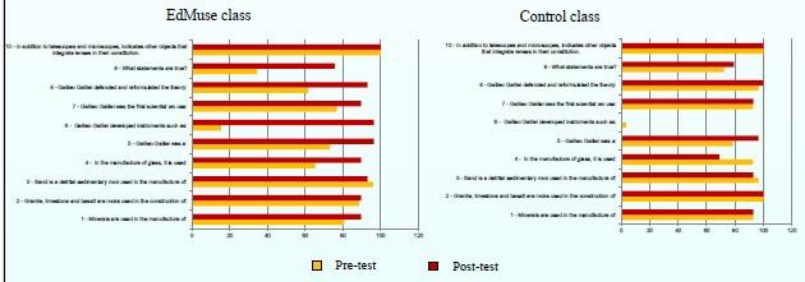
After that, a brief review on the topic of «Lithological resources of Portugal» was conducted, with the presentation of samples of granite, basalt, limestone and sand rocks; the students were asked to identify and indicate possible applications of the rocks and minerals.

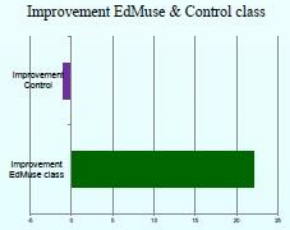
Exploration of the electronic presentation "EdMuse learning object", "THROUGH THE EYES OF GALILEO - LENSES FOR A TELESCOPE".

In articulation with the discipline of English, this electronic presentation will be addressed again, within the scope of the English course.

Finally the students answered the questionnaire about the "EdMuse learning object". Also the students were informed that in 2017/2018 they will visit the **National Museum of Natural History and Science**, in Lisbon, to complement their studies. Intuitive thinking, logical reasoning, concentration, analysis, memory, were the skills of the students put to the test in the exhibitions visited in Museums.

Results and Conclusions





The results of the questionnaires of students who have used the EdMuse approach have showed increased learning compared to students of control group.

On conclusion is from all interest that multidisciplinary would be used. Museums are a very rich information source on the majority of school themes, besides that, they give us a very comprehensive scientific knowledge.

The António Gedeão School often conducts study visits to museums, and from now, this study, support this educational procedure.

Photos

OBSERVATION OF THE SUN WITH A TELESCOPE IN THE SCHOOL ANTÓNIO GEDEÃO BY NUCLIO ASTRONOMER MÁRIO RAMOS

NATIONAL MUSEUM OF ARCHEOLOGY, LEFT, AND NATIONAL MUSEUM OF NATURAL HISTORY AND SCIENCE, RIGHT, IN LISBON

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Lenses and vision: From Glass to telescope

César Marques and Luís Esturrado
Physics and Chemistry Teachers at Escola Profissional de Almada, Almada, Portugal

General description

The objectives of this project were to develop an interdisciplinary thematic unit plan on Lenses and Telescopes. At our school, Escola Profissional de Almada, we applied the traditional methodology in 2 control classes (one class from Automotive Mechanics and another from IT) and Inquiry-Based Learning (IBL) methodology with 2 main classes (from the same study subjects).
With the traditional methodology (teacher centredd), the teacher used PowerPoints. In the classes with IBL methodology, students were left by themselves to explore the given Inquiry Learning Scenario. The 4 classes were formed by students with many personal and social problems, which reflected on their learning problems.

Learning objectives

- To learn about Lenses;
- To learn about Telescopes;
- To learn about Galileu's and Kepler's Telescopes;
- To learn about Real and Virtual images;
- To investigate lenses properties;
- To build Galileu's and Kepler's Telescopes.

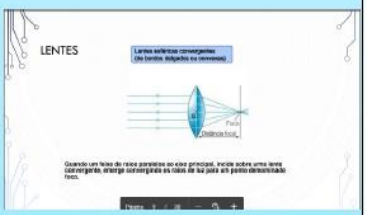
Method

The IBL lesson was created using Museo Galileo images and simulations, lenses and RGB kits from Eyest Photonics Explorer, and Graasp (Go-Lab) environment for the Inquiry Learning Scenario (ILS). The traditional class Powerpoint was created with images found on the internet and books.

The questionnaires were administered in two moments: before and after the thematic unit was carried out, in all four classes involved. The final verification questionnaire will assess the abilities and skills acquired by the students and will reflect the degree of learning achieved, as a result of IBL lessons.

In traditional classes, teacher centered, the teacher used a regular Powerpoint shared by teachers from other schools.
In IBL classes, students worked by themselves with no help from the teacher, usind the given ILS, "Thru the eyes of Galileo", using Graasp (http://www.golabz.eu/spaces/thru-eyes-galileo) and the Eyest Photonics Explorer materials.

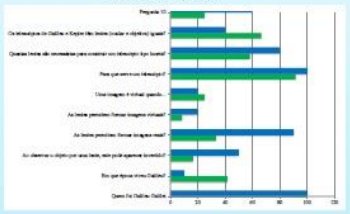
IBL Lesson:



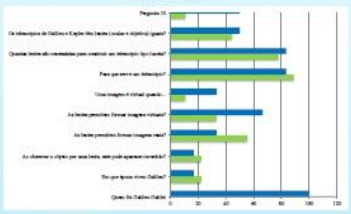
Results and Conclusions

Despite working alone, the IBL classes have shown better results. The IBL students also asked the teacher for more classes, because they "can see and explore" the concepts by themselves.

Experimental classes

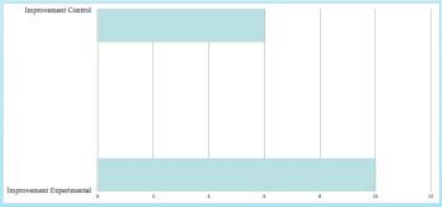


Control classes

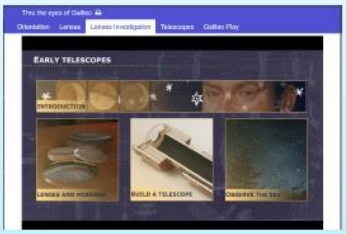


% pre test correct post test correct

Experimental and Control Classes Improvement



Photos



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The weather

Ema Teixeira
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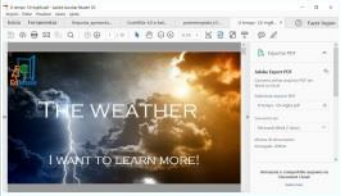
General description

The aim of this project was to enlarge student's knowledge about the "Weather" by using other methods than the traditional ones, like digital resources of cultural heritage, audio visuals and EdMuse platform. With a multidisciplinary vision we can develop curiosity and willing to learn on students.

The two classes involved on the project were from the third grade. With the main class C6 – 25 students – we used EdMuse resources (experimental one), with the secondary class C5 – 28 students- we used the traditional methods (control one).

It was interesting and motivator and they showed a lot of enthusiasm and dynamic. They reveal a great interest using EdMuse resources to search everything that they could know about the weather, besides what was shown during the class. They reveal little knowledge about museums, and the idea that they have about museums is much reduced. On their ideas museums only have furniture, old cars, and ancient statues.

Method



The experimental class had specific guidelines: we used digital resources and introduced musicological and heritage resources from

-EdMuse platform:
-Galileo Museum;
-National Art Museum;
-Van Gogh Museum.

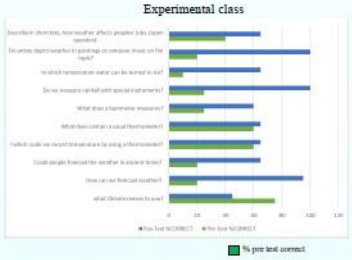
During the class we used differentiated strategies:

Slides shows, vídeos, music, music lyrics from portuguese songwriters

On conclusion is from all interest that multidisciplinary would be used. Museums are a very rich information source on the majority of school themes, besides that, they give us a very comprehensive scientific knowledge. I would like to mark the use of Information and Communication Technologies importance, since the students show curiosity on their results on pre and post-test.

Results and Conclusions

The first questionnaire was made with 53 students, 25 from C6, the main class, and 28 from C5, the secondary class. In general all the students showed up some problems giving the right answer.



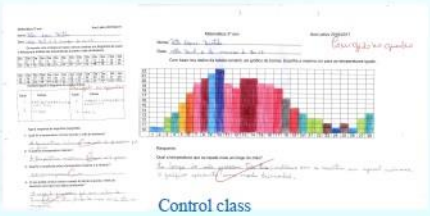
The results of the questionnaires of students who have used the EdMuse approach have showed increased learning compared to students of control group.

On conclusion is from all interest that multidisciplinary would be used. Museums are a very rich information source on the majority of school themes, besides that, they give us a very comprehensive scientific knowledge.

The use of Information and Communication Technologies importance, since the students show curiosity on their results on pre and post-test.

Photos

Experimental class



Control class

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Galileo, Aristotle and Copernicus, his findings and his method

João Tremoço
teacher

General description

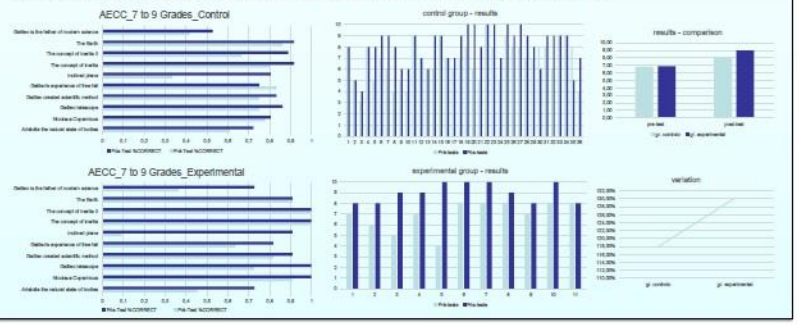
- this unit addresses Galileo, his findings and his method – observation and experience;
- it was applied to students with 12+ years old, belonging to 7th grade classes of the Coimbra Centro School Cluster;
- control group with 36 students, 4 with 12 years old (3 female and 1 male), 28 with 13 years old (18 female and 10 male) and 4 with 14 years old (2 female and 2 male);
- experimental group with 11 students, 5 with 12 years (4 female and 1 male), 4 with 13 years old (3 female and 1 male) and 2 with 14 years old (1 female and 1 male);
- the lesson was applied divided in two moments, in April 2017, each one of them with more or less fifty minutes;
- it addresses the topics of the Portuguese curriculum for the 7th grade;
- it was designed using digital resources, addressing cultural heritage and multidisciplinary purposes;
- exchange of good practices between teachers;
- fit to promote new approaches to scientific knowledge within educational topics.

Method

- Use of digital resources, available in online platforms, concerning both scientific and cultural heritage data, collected in museums sites;
- multidisciplinary approach, addressing arts, literature and music, among others, motivating students and allowing them to acquire the topics or consolidate them;
- promote collaborative work between students;
- designed of a didactic unit, along with a questionnaire addressing their topics;
- explain the unit to the students between pre and post-test;
- use of a friendly approach to keep students interested during the unit;
- use of ICT, allowing students to access several important data that better illustrated the educational topics;
- a multimedia didactic unit, using MS Power Point®, with hyperlinks that connect directly to museums.

Results and Conclusions

- the results show that the control group has improved the results between pre and post-test;
- however, the experimental group has improved even more;
- the initial averages were similar (6,81 vs 6,91);
- the post-test averages were different enough to find them significant (8,03 vs 9,00);
- it's possible to link this data with the different approach applied within the experimental group;
- of course, these results must be validated in a larger sample…
- this should happen applying this unit and the questionnaire to a wide range of students.



Photos

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Presentations of the Final Conference

The educational systems of the partner countries of the EdMuse Project

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***Abstract*— The present article discusses the structure of the educational systems of the three partner countries of the EdMuse Project, that is Greece, Italy, Portugal. It also refers to the way that this structure affected the formation of our project's target age group. Finally it highlights the way that each system has corresponded to contemporary European educational dilemmas concerning the use of cultural heritage and ICT's.**

Index Terms *learning process, teaching results, educational tool, multidisciplinary lessons*

I. INTRODUCTION

Greece, Italy and Portugal, the three partner countries of the EdMuse Project have a remarkable background as far as it concerns the three components of the Project, that is cultural heritage, education and technology.

All three countries have an enormous cultural background saving some of the most important monuments of the global civilization.

Belonging to the European Union they share common queries about educational policy, about the interconnection between school and society and about the new methodology of Didactics.

All three countries also have to deal with the crucial issue of the penetration of technology in the educational institutions.

The way that each country has corresponded to these critical queries is the theme of this presentation.

II. LOCATING THE TARGET AGE GROUP

Before presenting the structure of the three educational systems, we can refer to the position of the target age group 8-12 years. The partners dicussed and concluded in this age group for three reasons:

a) It is situated, for all three countries, at the heart of compulsory education since in Greece compulsory education lasts from 5-15, in Italy from 6 to 16 and in Portugal from 6 to 18.

b) This age group covers both forms of the Natural Sciences Subject: the independent form (in 10-12 years) and the integrated one (in 8-10 years) where Natural Sciences belong to a wider subject together with Geography, Citizenship, Earth Sciences, even History in some cases.

c) The target age group of 8-12 also gives us the chance to study the multidisciplinary teaching executed by the only teacher of all subjects, while at the older ages the subject is taught by the separate specialised teacher, a fact that makes multidisciplinarity a matter of good cooperation between the teachers.

III. STRUCTURE AND DILEMMAS IN THE THREE SYSTEMS

Let's have a look at the structure of the three systems in an alphabetical order:

In Greece [1] children of 4 years attend the pre-Kindergarten optionally. The Kindergarten though is compulsory. The primary school lasts from 6-12 years, so the target age group of our project is situated at the third, fourth, fifth and sixth grade. Later comes the secondary education: three years in Gymnasium and three years in Lyceum. Universities and Technological Institutions concern students of 18 years that participate in the National Exams.

The Greek educational system was not familiar with the principles of multidisciplinarity and the books are still written without taking multidisciplinarity into account. However in the year 2002 an important new subject entered the curricula named: Flexible Zone. For 2, 3 or 4 hours a week (depending on the grade) students, separated into four-person groups would deal with project work examining a topic they had selected in a multidisciplinary way. The topics would concern either Culture or Environmental Issues or Issues of Health Promotion. The freedom to choose topic as well as the new methodology suggested attracted the attention of teachers and familiarised them with the multidisciplinary principles which the teachers implemented in the other "official" subjects of the school, as well. In this way, nowadays the Greek teacher can easily design and implement a multidisciplinary teaching.

As far as it concerns the ICTs in Greek schools, the economic crisis has raised a big problem: the equipment of the computer laboratories in the schools cannot be updated because of scarcity of funding. We cannot predict how the society will correspond to this, if, for example the local communities will try to donate equipment to schools or if the parents will try to raise funds, but for the time being the problem is there. As far as it concerns teachers' education, the state has organized nationwide seminars for all teachers of primary and secondary education in the basic skills of

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ICT. Updated training in educational software is currently offered to teachers but in a narrow range.

Let's have a look at the Italian educational system: The two years of pre-school education is not compulsory [2]. Primary school starts at 6 years and our target group attends the 3rd, 4th, 5th and 6th grade of it. At the age of 11 starts the first level of the secondary education. 1st and 2nd grade of this level also belongs to our target group. Afterwards comes the second level of secondary education up to 18 years, when students follow the higher education.

In 1997 with the so-called "Bassanini law", Italian schools gained the important privilege of autonomy. The Italian state defines only the national educational goals and schools are free to pursue them with the curricula *they* choose. So one can find classes attending 27, 30 or 40 hours a week or 5 or 6 days a week. A clear and dynamic guideline is that of providing a European perspective in their curricula, implementing cross-cultural activities and participating in European projects communicating with other European schools through pen-pal or e twinning etc. The teachers of the school have to compose the Educational Offer Plan which defines the cultural character of the school, describes the subjects offered (compulsory and optional), explains the way in which the school evaluates students, defines the research activities to be implemented in class, informs parents about the role of every teacher in the school organisation etc. The Educational Offer Plan is an important document which local authorities have to approve and take into account in order to facilitate its implementation.

As far as it concerns the technology penetration in Italian education we have to mention that not all schools are equipped with multimedia laboratories and, if they are, not all teachers have the skills to manage ICT. To date, as the report of the Italian partner refers [3], there is a serious lack of uniformity in the ability of teachers to master the use of new technologies.

Going on to the Portuguese educational system we find pre-school education as optional, with the compulsory education ranging from 6 to 18 years [4]. Basic education extends from 7 years to 15 and the secondary from 16-18. Basic education is divided into three cycles with our target group concerning students of 1st and 2nd cycle.

To the European debate concerning Educational Decentration back in 2009, Portugal has answered with the creation of School Clusters [4], that is the bringing together of many separate schools that obtain the power to take responsibility for some of their own decisions and at the same time save funds, reducing the cost of administrative procedures. However the "center" seems to still hold significant control over schools through the exams that take place at the end of the fourth grade of the first cycle, that is for 10-year-old students. The results of the exams are used for the evaluation of schools and teachers. The exams concern only Portuguese and Mathematics. So, during the last decade the teaching process in the first cycle focuses more and more on these two subjects, especially due to exam pressure, which led to the reduction of investment in other subject areas in matters of training, time allocated and material resources. For instance, the study visits to museums and other cultural sites have been reduced. Currently, each class group visits a cultural place once a year.

As far as it concerns teachers' training, it is mandatory for the teachers to attend a 50-hour seminar every four years in order to update their teaching skills. They have the choice to devote 15 hours of them to ICT's but they are not obliged to.

A serious lack of uniformity in the teachers' ICT skills has been mentioned by the Portuguese partners [3]. The main reason for this gap is identified to be the scarcity of resources for a good, productive training programme.

After taking a glance at the three educational systems we can easily conclude that all three are, in various ways, affected by the economic crisis. The reaction that each society will present is a lingering question.

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Guidelines and Methodology for using Cultural Heritage in Science Education: the EdMuse Project

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***Abstract*— In this paper we are presenting a summary of methodology and guidelines for using cultural heritage digital resources developed in the scope of EdMuse project. The methodology and guidelines are based on a constructivist model for natural sciences didactic and museum education and on a reflective model for teachers' professional development. The main steps of the Guide and methodology involve the reuse of digital resources stored in digital libraries, as Europeana, for planning multimedia lessons, involving the students in this process and analyzing the learning results achieved through these activities.**

Index Terms *cultural heritage digital resources, reuse learning objects, guidelines and methodology*

I. INTRODUCTION

Cultural heritage resources, namely digital resources present in museums, have a great potential for educational purposes. Some reasons have been pointed for this potential, namely, it has been emphasized that cultural heritage enhances contextualization and interdisciplinary; it allows to promote transversal competencies such as cultural awareness and social and civic competences. Engaging with digital cultural heritage in meaningful and critical ways can enhance the European dimension in learning, stimulate reflection and debate, and actively contribute to a sense of belonging to a common cultural space shared across. Also, cultural heritage digital resources presented in museums may be used and reused in different contexts.

The European Commission has also called attention to the need to explore ways to use and reuse cultural heritage resources. The European Digital Agenda identifies as a priority the re-use of digital content related to the cultural heritage to develop learning content [1]. The museum objects can become a vehicle for educational content, as they can provide information related to its nature, to its use, to its representation in different historical contexts and disciplines. Being "image" and "content", they are candidate to become an effective contribution to the production of multidisciplinary and personalized educational courses. The presence of numerous digital resources made available in open data mode of the museums will ease their [1].

However, previous studies show that museum resources have not been used systematically in the framework of classrooms and that on site visits are not always producing the expected results in terms of learning [2]. Innovative educational resources are then needed to promote the reuse of digital museum resources and they should be easy to use, adapt and develop. The Erasmus+ Project "Education and Museum: Cultural Heritage for learning science" aims to promote innovative methods of teaching and learning through reusing digital learning objects of museums- In this article it is presented the methodology and guidelines developed in the scope of the project for teachers to plan, implement and evaluate multimedia lessons. First, theoretical models for natural sciences didactics and museum education are presented following guidelines and methodology for using cultural heritage digital resources and Edmuse platform and promote teacher professional development.

II. NATURAL SCIENCES DIDACTICS AND MUSEUM EDUCATION THEORETICAL MODELS

The Natural Sciences Didactics and the Museum Education followed an almost common theoretical process, passing from the behaviourism to the social constructivism, more recently combined with socio cultural approaches. That process affected the Natural Sciences Curriculums and the Educational programs of the museums, which changed their focus from the "subject" to the "learner".

Nowadays the common ground between museum education and Didactics of Natural Sciences is the theory of the constructivism. The educational theory of the constructivism considers that students construct the knowledge themselves, through social interaction and language use, and they interpret the various concepts and ideas through their personal models, widely known in natural sciences didactics as conceptual representations. Constructivist educational theory argues that in any discussions of teaching and learning we should focus on the learner. The mains teaching goal on Natural Sciences Didactics is to help students to learn how to learn, through multidisciplinary approaches, immediate experience, use of original resources and interactive initiatives.

The "hands on" and "minds on" activities of Dewey, the theories of Vygotsky and Bruner, which highlight the role of cultural background of learning and the theory of multiple intelligences of Gardner converge on using museum education in order to design and implement multidisciplinary teaching approaches.

In order to facilitate the full development of each student, it is necessary to provide an effective strategy for learning through various educational procedures. Teachers must develop teaching

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learning scenarios on how to use the platform in a constructivist model. The constructivist-teaching model for the Natural Sciences evolves into five phases and it is proposed to develop EdMuse multimedia lessons:

- Orientation
- Promotion of children's representations
- Reconstruction of children's representations
- Implementation to everyday life
- Review

III. GUIDELINES FOR TEACHERS TO IMPLEMENT MULTIMEDIA LESSONS AND PROMOTE REFLECTION AND PROFESSIONAL DEVELOPMENT

The Guidelines for teachers present general orientation for teachers to use EdMuse platform to implement multimedia lessons aiming to involve students and stimulate their curiosity in science subjects. These Guidelines present teachers' tasks (design, implementation, tests) and point to a reflective approach in teacher practice as the process involves gathering data about the process, so teacher can analyse students learning improvement and reflect on the reason associated with the process. The general steps involve:

- Pre and post-test given to the classes.
- At least two classes are needed, the main class and a control class.
- The main class is taught through EdMuse or other digital resources of cultural heritage and in a multidisciplinary way.

The control class follow its usual, traditional methodology of each country for the same topic:

- Time table.
- Pre-test, maximum 4 days before teaching.
- Implementation of the didactic process.
- Synthesis of children's report in a chosen form (poster, .ppt presentation etc.).
- Post-test, maximum 4 days after the end of the implementation.

The goal of the comparison is to define if children construct knowledge through our teaching and if there are differences or no in the construction process of the main class and the control class.

The form of the pre and post questionnaire, which should be the same (in form and content), has to contain:

- 10 questions.
- If multiple choice, 3 answers each, only 1 correct.
- yes or no/ true or false questions.
- One open question.

The questions should be related to the topic and not to the process.

IV. METHOD FOR USING CULTURAL HERITAGE DIGITAL RESOURCES AND EDMUSE PLATFORM

EdMuse Platform is a virtual learning environment based on collaborative work to share content and learning objects among many schools. EdMuse Platform collects the metadata of cultural heritage objects extracted from the Europeana Digital Library. It aims to allow teachers to build a personalized path through web access to the Museums Catalogues and to download images and information on museum objects to be used in the production of multimedia lessons. Teachers and students logged in the project have an opportunity to create their own catalogues structuring specific paths in which they are going to insert the objects of their interest; they have also the option to add other descriptions visible to all using the annotation tool. Teachers can also upload their multimedia lessons in the platform and share them with other teachers.

The User Guide for EdMuse Platform to search and download museum object image and content for reusing them in multimedia lesson involve:

- To access to EDMUSE Platform and activate search engine in Europeana Digital Library. Users can insert the term or terms of search and click on the button.
- Select the useful images and save them. The images and the content will be saved in the collection area and the user can manage them.
- The user can choose to select one or more items and manage them to activate remove or download option. If the user activates the download option the system allows the user to capture images and content for its need.
- The collection.zip contains the html file of object form and images of museum object useful to reuse in the multimedia lesson.

As the core idea of EdMuse project is to reuse existing data about cultural heritage some issues about Terms of Use of each database used to develop multimedia lessons must be considered, taking into account under which conditions it can be re-used.

V. CONCLUSION

This paper presents the guidelines and methodology developed under the scope of the Erasmus+ Project "Education and Museum: Cultural Heritage for learning science". In the scope of constructivist and reflective approach, teachers and students are challenged to (re)use cultural heritage digital resources included in museums, developing personalized and adaptive eLearning pathways and analysing the impact of the process in the professional and academic learning.

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Methodology and guidelines for using the EDMUSE platform in school environment

Development of a didactic unit on science topic

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***Abstract*— Cultural heritage education plays a key role in multidisciplinary teaching. The knowledge and use of cultural heritage as a citizen's right to participate in cultural life, reaffirms the value of cultural heritage both a source for human development and the enhancement of cultural diversity and promotion of intercultural dialogue. For all these reasons, the school must promote the use of cultural heritage as a common factor in the teaching of curricular disciplines, in a multidisciplinary and transversal perspective. Starting from these assumptions, we present the Methodology and guidelines for using the EDMUSE platform in school environment and how making a didactic unit on science topic, using museum objects on the EDMUSE platform, selected among the contents of the programming for targets, so as to ensure the development of core concepts of the discipline in a multidisciplinary and transversal perspective. The project goal is to give students the tools of understanding and intervention through the skills and abilities acquisition to use the knowledge and foster a learning environment motivating, innovative and integrated teaching approaches supported by collaboration between schools and museums .It is based on the use by students and teachers of objects belonging to the cultural heritage made available on the web and then reused.**

Index Terms *cultural heritage in education, multidisciplinary and digital didactic unit*

INTRODUCTION

In order to facilitate the full development of each student, it is necessary to provide an effective strategy for learning through various educational procedures. In the Erasmus+ Project "Education and Museum: Cultural Heritage for learning science", each partner plans a "teaching unit" on a topic of science, selected among the contents of the programming for targets, so as to ensure the development of core concepts of the discipline [1] in a multidisciplinary and transversal perspective. The goal is to give students the tools of understanding and intervention through the acquisition of skills as the ability to use the acquired knowledge.

II. A TEACHING ACTION: FROM TRADITIONAL LESSON TO STUDENT CENTERED LEARNING

A teaching action, built in order to make significant the learning context, is based on the following scheme:

- Analysis of the initial situation learn.
- Educational goal to be achieved.
- Paths that lead to the goals.
- Final test.

The design scheme, in our case, involves all teaching staff in the construction of teaching units and not just the science teacher, since the objective is the creation of multidisciplinary digital material, focused on overcoming a teaching based on the transmission/receiving content, typical of 'traditional teaching. Thereby, it fosters a learning environment motivating and teaching innovative and integrated approaches, supported by collaboration between schools and museums [2] that is based on use by students and teachers of objects belonging to the cultural heritage made available on the web and then reused. In this way, we move from the traditional lesson to an innovative lesson. In the traditional *ex cathedra* lesson the teacher provides information and the students concentrate their efforts especially in following the explanation and taking notes. The traditional lesson favors the most gifted students. Even the most gifted students, however, have difficulty in supporting their attention and interest for an entire hour or more. Bodner says, "teaching and learning are not synonymous: we can teach – and teach well – without the students learning." According to constructivism[3], which bases its roots in Piaget's work, knowledge is built by the individual. Driver *et al*. propose a "social construction" of scientific learning: scientific knowledge is built when students are actively engaged in discussions and activities related to scientific issues. The constructivist model can be summarized in a single sentence: Knowledge is built in the mind of the learner.

III. METHODOLOGY FOR USING THE EDMUSE PLATFORM IN SCHOOL ENVIRONMENT

The new methodology favors:
a) *capacity for action*, the student is the protagonist of his learning process, interacts with objects and subjects, makes something new with his own activity;
b*) metacognition*, the student is led to reflect on the cognitive processes and learning strategies that activates;
c) *collaboration*, the student must take into account the resources made available from the others because from the

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proper use of these derives the quality of the product that he achieves;
d) *culture*, the student learns and shares a way of life and thought, producing work with others.
Student, through the thematic routes and the observation of the museum object, is involved in the discovery of ancient history, science, art and technology in a context certainly more appealing than the classroom where daily lives his role to learner[4]: peoples, events of the past, tools, inventions that have been realized through the collections, the objects, the evidence preserved in the traditional and virtual museum environment. The relationship between school and museum, through the use of the scientific and digital realities that compose it, is both an expansion of training and a fun and valuable experience for the training of students and teachers. Especially the university museum is a place of integrated culture, based on the observation of objects and the possibility of interacting with them, where the student may track through the use of "exhibits", what he learned, theoretically, in connection with the historical and artistic disciplines[5].

In the construction of interdisciplinary multimedia products, the on-line access to the EdMUSE platform, through which you can create multi-disciplinary connections in media mode, it allows, once the teaching units are defined, to use the resources of the museum heritage, following the choice of development and deepening of the teachers on the subject chosen. The team organizes an educational trail on a topic of science in accordance with the disciplinary content belonging to the basic curriculum, which connects other disciplines transversally and can acquire different skills. The argument is segmented into paragraphs. Each paragraph is listed as a node in the hypertext construction. Each node provides historical, geographical, scientific information related to the subject that gives title to hypertext and in each node will be inserted images selected from the catalogs of museums in support of information page. The hyperlink path made by teachers, made of texts and images, enriches the lessons, creating a highly stimulating and motivating learning environment for students and teachers. Hypertext is a document through which you can switch to other information in a simple and immediate means of hyperlinks (links), using multiple media simultaneously, integrating them into a single communication object: text, images, sounds, movies, animations, etc. The realization of a conceptual map, during the design phase, helps teachers to graph their knowledge about the subject:

- identify the concepts;
- proceed to the creation of the associative relationships between them (words-node);
- relate the different concepts in a clear and correct way (word-bond);
- each conceptual-map node represents one or more pages of hypermedia.

During the research of materials, it is useful to register on the EDMUSE collaborative and open platform, achieved by the use of open data technology, aimed at making accessible, to teachers and students, digital cultural heritage resources made available in open mode by museums. Typing a word, it will be searched in the title, in description or in any annotations of digital resources, so you activate the search for one or for all institutions that have provided their digital heritage. Registration and access to "My Catalog", allows you to store search results and reuse the same for learning content. The complete search takes longer but provides feedback of the terms also sought in the annotation fields and descriptions. The EdMuse platform allows you to capture useful information to build lessons or research in hypermedia format. The captured information can then be integrated with other content using different programs: powerpoint, frontpage or any text and graphics editor that allows you to save in HTML. Below is an example of multidisciplinary lessons made by teachers of science, history and technology in two classes of primary school and lower secondary school, using the museum digital resources, downloaded from the EDMUSE platform.

IV. ASSESSMENT

Concurrently with the construction of Unity Teaching is useful to prepare the verification tools: questionnaires with multiple answers relating to chosen topic. The structure of the questionnaires is the same that teachers usually use during the school year as a verification tool to test knowledge, previous and acquired by students. The questionnaires are administered in two times: before and after the didactic unit is carried out. By he administration of the initial questionnaire, the basic knowledge is acquired: all the information that the student possesses regardless from those provided by the school such as the result of input and stimuli that he receives from his family and from the social and environmental context in which he lives. These skills are known as the "cultural baggage". The final verification questionnaire will assess the abilities and skills acquired by the students and will reflect the degree of learning achieved as a result of multimedia lessons (comparing pre / post within the class).

V. CONCLUSIONS

Results assessment has been measured by means of feedback forms filled by the teachers and students involved in the project: the general outcome is positive. Integration with digital resources is useful when the teacher prepares his lectures. In this phase, the opportunity to gain access to the digital resources of museums constitutes a valuable support to capture images of museum objects and information connected to content related to the topic discussed in the classroom.

The application will also allow teachers to build a customised path online; using programs or software products. It will be possible to create an e-book, according to a communication strategy based on a continuous process of collaboration between the museum and the teacher. The teacher will be able to access to online catalogue of museum objects, to choose the content and the images useful to describe the subject of a curricular discipline. This informal content can be integrated with formal content for making multimedia lesson and the teacher can acquire and stored it in a customised path.

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In summary, teachers, thanks to the new methodology, can:

- acquire the skills to access the on-line digital resources of various museums,
- register on the website made available to create custom locations for the storage of museum objects and the link information selected,
- trigger the download of custom locations on their own computer,
- acquire the skills to organize content and the use of programs for the production of lessons in ebook format.

Hypertext products will be made available on the platform, accessible to teachers and students with the goal of creating a virtual community for learning and building of knowledge.

Collaboration between schools and museums, also through a digital platform, is a factor in developing a bridge between the two learning environments and for the development of innovative didactics.

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Museum Resources for learning at Museo Galileo

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***Abstract*— Due to its primary mission, which is the promotion of the scientific heritage and the dissemination of scientific culture, Museo Galileo constantly improves access to its resources taking advantage of innovative storing methodologies and standard web technologies while promoting both initiatives aimed at the scholars' community and activities intended for the schools and a familial public.**
Attracting the attention of an ever-wider public, trying to meet their expectations, is the goal that every museum should pursue. Museums are extraordinary catalysers of cultural opportunities, and can be very effective for school education by offering non-formal extra-school occasions of learning.
For the students and their teachers in particular, the visit to the museum no longer remains an isolated experience but constitutes an integral part of a multidisciplinary pathway in a continuous dialogue between school and cultural institution that make students protagonists of their social and cultural growth.

Index Terms *digital cultural resources, museums, learning environment*

I. INTRODUCTION

Located in the heart of Florence, Museo Galileo – Institute and Museum of the History of Science (http://www.museogalileo.it/) is one of the foremost international institutions in the history of science, combining a distinguished museum of scientific instruments and an institute dedicated to the research, documentation and dissemination of the history of science in the broadest sense. It has been found in 1927. Museo Galileo is heir to five centuries of scientific collecting, started by the Medici family and carried on by the Lorraine, which demonstrate the central importance given in the past to scientists and scientific instruments.

II. MUSEUM COLLECTIONS

Its scientific-instrument collections contain more than 5,000 items, about 1.000 of which are on permanent exhibit in the 18 rooms currently open to the public. The displays cover two floors of the Palazzo Castellani. The rooms are arranged by time period and topic. The first floor is dedicated to the instruments of the Medici collections, where visitors can admire fine mathematical instruments, Galileo's original instruments (including the two surviving telescopes of those personally made by the Pisan scientist), the instruments of the Accademia del Cimento, and the extraordinary collection of terrestrial and celestial globes, dominated by the monumental armillary sphere built by Antonio Santucci. In the rooms of the upper floor the scientific activity of the Lorraine period is illustrated by: the conspicuous Tuscan – and, more generally, Italian – contribution to the development of electricity, electromagnetism and chemistry; the extraordinary series of obstetrical waxes; the chemistry cabinet of Grand Duke Peter Leopold; and the beautiful and instructive machines for demonstrating the basic principles of physics, built in the workshop of the Museo di Fisica e Storia Naturale.

The premises of the Museum also host a specialized library that houses about 150.000 works concerning the history of science. The antique book collection, consisting of nearly 5.000 works, is supplemented by several 19th-20th century collections as well as a contemporary collection which has an annual growth of about 1.800 new acquisitions. The library is also home to an interesting historical photo archive and several 18th to 20th century archival collections.

III. DIGITAL COLLECTIONS

Due to its primary mission, which is the promotion of the scientific heritage and the dissemination of scientific culture, Museo Galileo has soon started to digitize its collections, taking advantage of innovative storing methodologies and standard web technologies to improve access to its resources.

The information material is collected in several applications, including the Virtual Museum, the Digital Library, the Scientific Itineraries in Tuscany, and many online exhibitions. These applications are produced using internally developed tools that allow also to manage metadata.

The Virtual museum, constantly updated since its first online publication, in the late 1995, presents the more than 1,000 objects on permanent exhibition through colour images and detailed descriptions. The user can access biographical data, explore "In Depth" information and find contextual background related to the selected object. To present the reconstruction of the historical contexts and to explain the functioning of the most complex objects, more than 150 simulation animations and/or videos are also made available.

The Digital Library was instituted in 2004 for the purpose of publishing digital collections on themes of interest to the history of science. It contains the digital version of documents of different types, such as printed works, manuscripts, photographs, and objects, scientific instruments in particular. The Digital Library may thus be considered an information system used to consult the wealth of knowledge offered by the thematic collections as a whole, consisting of digital resources in various formats – images, texts, video, audio, etc. The most

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substantial part undoubtedly consists of the publication of over 4,000 works, many of them rare.

The Scientific itineraries in Tuscany presents the Region as a great "multi-centre museum", whose scientific heritage, offered in a cultural tourism key, is integrated with its treasures of art. However, the product is not intended to provide a complete census, but to testify, through a conspicuous number of examples, the important place historically held by science in the Tuscan cultural tradition. The objective of the application is that of informing the general public of the wealth of historical-scientific testimony existing in Tuscany, thus encouraging the development of cultural tourism interested not only in a few universally known attractions but in all of the less familiar sites, unjustly ignored by the great flow of tourists. The application is both an aid to planning a trip through Tuscany and a tool for virtual visits to places of historic-scientific interest. Within this context, special emphasis has been given to two giant figures of science, Leonardo da Vinci and Galileo Galilei, both of whom had deep-rooted ties with the Tuscan territory, of which important, though still little-known, traces remain. The great mass of data collected in the last few years is impressive: there are 1,850 pages for each language, and 4,800 pictures.

IV. COLLABORATIONS

In recent years the Museo Galileo, in collaboration with other institutions, has participated in several initiatives designed to broaden its outreach to a diverse audience, always focusing on its mission. These initiatives were not only addressed to the public, but also aimed at metadata sharing, making information usable by machines and other content producers. This led to the presence of the museum on highly sought-after platforms, such as Google Cultural Institute, Google Maps, Europeana, and Wikipedia.

Google Cultural Institute is the Google's initiative which collects multimedia stories made by a number of prestigious cultural institutions all around the world. Museo Galileo has developed some themes in order to present its own collections, the main topics of the exhibitions, and the activities carried out by the Institute. In particular, on the platform, users can find the Medici and Lorraine collections, the Library of the Institute, and a study on Galileo and space exploration which connects the museum exhibition with the astronomical discoveries of the scientist.

Another opportunity to reach new audiences, and at the same time to provide a useful service, is Google StreetView. In this case the virtual tour of the Museum and part of the Library is made available both by the Cultural Institute and Google Maps. The high quality of the images allows a real virtual tour of the Museum, while presenting at the same time the descriptions for the most significant objects. The service has both a contingent and a long-term value, since it depicts the Museum at a given moment, thus constituting a precious testimony for future reference.

Europeana is an EU digital library that brings together the contributions – including artworks, artefacts, books, manuscripts, videos and sound recordings – of more than 3,000 cultural heritage institutions across Europe. While the digital objects that users can find on the platform remain on the networks of the cultural organizations that created them, Europeana collects the metadata of those items mapped to a single common standard, the Europeana Data Model (EDM), that makes them more easily accessible and searchable. Realizing the huge potential of the project, Museo Galileo has been involved in it since its beginning when the European Digital Library Network (EDLnet) launched a prototype of cross-domain, user-centered, multi-lingual portal on November 2008. Since then, the museum has provided Europeana with metadata of its own Catalogue of scientific instruments and the application Scientific itineraries in Tuscany, periodically updating and enriching the semantics of the digital objects.

More recently Museo Galileo has decided to release its own data also on the Wikipedia platform. Over 450 Italian and English records from the Museo Galileo website which are pertinent to entries not yet included in Wikipedia, about 130 pictures and some videos have been shared with the Wikipedia community. This project notably implemented the topics related to the history of science in the most visited online encyclopedia.

V. CONCLUSIONS

From the point of view of the Museum, the benefits of this collaborations did not take long to show.

In the case of Wikipedia and Google, for example, the increase in visibility has been significant. It should not be forgotten that nowadays effective communication strategies are essential to maintain the visibility of an institution in the enormous amount of information available on the web, while preserving at the same time a reliable and trustworthy image of the organization within the community. Moreover, the presence on platforms with different characteristics and user base allow not only to reach a wider audience but also a diversified one in terms of knowledge, interests and skills.

Furthermore the presence of the museum collections on platform aimed at collecting and sharing metadata based on common standards, like Europeana, allowed to enhance and enlarge the information heritage, connecting it with different datasets of other similar European institutions, so as to form a common catalogue the value of which is much greater than the sum of the individual parts, and thus creating a basis for an open, and continually expanding knowledge.

In the case of the participation in the EdMuse Project, the indexing and presence of the museum's data, images and videos on various platforms make it easier and quicker the reuse of the resources by the teachers and students involved.

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Cultural heritage in science education: the Edmuse project experience in the class

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***Abstract*— This paper describes the plan of multimedia interdisciplinary Teaching unit " The Solar System" and its application in the classroom, following the Guidelines and method for using Cultural Heritage digital resources developed by the EdMuse project.**

Index Terms *cultural heritage digital resources, reuse learning objects, guidelines and methodology*

I. INTRODUCTION

Erasmus+ Project "Education and Museum: Cultural Heritage for learning science" aims to promote innovative methods of teaching and learning through reusing digital learning objects of museums. This aim can be achieved though the characteristics of the Edmuse platform that enable personalized and adaptive Learning pathways.

The aim of EdMuse was to invite teachers to plan "teaching" units on a topic of science, selected from among the contents of the programming for targets, so as to ensure the development of core concepts of the discipline in question [1] in a multidisciplinary and cross perspective.

The implementation of the project was developed from January to April 2017 and the general steps involved:

- the teacher's training,
- the design of the teaching unit,
- the provision of pre-didactic questionnaire,
- presentation of the multimedia lesson to students,
- the administrate of questionnaire for impact evaluation of methodologies for learning the sciences.

II. THE CONSTRUCTION OF AN INTERDISCIPLINARY TEACHING UNIT: "THE SOLAR SYSTEM"

The objectives of this project were to develop an interdisciplinary thematic unit plan on our solar system. Our solar system has many teaching materials and shows many educational opportunities. It is also a topic in which different areas of study can be integrated, keeping students interested and involved.

Our planets are very interesting and offer many questions that can bring children to form their own opinion and to use critical thinking.

The classes involved in the project were the two fifth grades of primary school "A. Manzi": VA class (experimental class – 23 students, 10 years old), who followed the multimedia lesson and VB class (control class - 24 students, 10 years old), who followed a traditional lesson on the same topic.

Learning goals fixed:

- To learn about the geocentric and heliocentric theory.
- To learn about the first astronomical tools.
- To learn about telescope and astronomers (Copernico, Galileo).
- To learn about the planets and their unique and identified features (e.g. size, distance from earth, sun etc.)
- To investigate the origin and the meaning of the name of the planets and correlate them with the ancient Greek and Roman myths and gods.
- To learn about some examples of works of art and poems related to the solar system.
- To build a model of the solar system and put the planets in the right order orbiting around the sun.

III. METHOD

The plan of multimedia lesson has followed specific guidelines: "Guidelines for teachers to implement multimedia lessons and to promote reflection and professional Development [2].

- Hypertext was created using multimedia tools and new approaches to scientific disciplines, highlighting the multidisciplinary aspects of the established topic, incorporating resources related to cultural and museum heritage.
- The necessary resources have been searched on museum platforms, particularly on the EdMuse platform.
- In the developed hypertext, different disciplines have been transversally integrated and different skills have been included in the ranged from linguistic to historical, scientific, technological, artistic content.
- As piloting/verification tools, a questionnaire was created, consisting of ten questions, one open and nine of multiple choice, related to the chosen topic, to monitor the learning processes.

After the presentation of the lesson, students of experimental class did a research on the same topic, using the same system for making relationships, associating theoretical knowledge with the objects experiences. Many of the children followed the models hown with great ease and competence both in the use of ICT and interdisciplinary links.

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IV. PRE/POST QUESTIONNAIRES

The questionnaires were administered in two times: before and after the Learning unit was carried out, in both classes (experimental and control) involved. By administration of the initial questionnaire basic knowledge – all the information that the student has independently from the school as the result of input and stimuli received from his family and the social and environmental context in which he lives – has been acquired. These skills are known as the "cultural baggage". The final questionnaire assesses the abilities and skills acquired by the students and measures the degree of learning improvement achieved as a result of multimedia lessons activities (comparing pre/post within the class).

V. COLLECTION AND PROCESSING QUESTIONNAIRE RESULTS

Questionnaires results have been entered and processed in Google form.

The results of the questionnaires of students who have used the technology approach have showed increase learning compared to students of control group. The experimental class in the pre-questionnaire, consisting of 10 questions, gained an average of 3,22 correct answers and in the post- questionnaire it gained an average of 8,52 correct answers.

While the control class in the pre-questionnaire gained an average of 3,54 correct answers and in the post-questionnaire it gained an average of 5,96 correct answers.

VI. CONCLUSION

The multimedia lesson presented in the experimental class was followed with great interest and curiosity. Probably the thing that kept the attention of the pupils was the unexpected connection of a purely scientific topic to museums-historical images concerning non-scientific disciplines.

The resources from our heritage used in the construction of hypertext have revealed a great potential for information regarding physical and material characteristics, geographic location, relationship with different disciplines.

Furthermore the museum object, used as an image associated with a concept, has been particularly useful for those pupils with cognitive, behavioral or attention deficit.

The aim of the EdMuse project was to promote a new ways of learning and teaching through innovative method, using technologies and open digital resources that can be non-formal content for design curriculum.

Considering the results of the tests and the interest and enthusiasm shown by the students, we can confirm that the EdMuse challenge had the expected results.

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“Basically I am a matter of light”*

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* From Georgios Seferis’ poem “On a Ray of Winter Light”.

***Abstract*— This paper discusses the concepts of “Light” and “Shadows” as studied in the Experimental Class of a Greek Elementary school. These concepts of natural sciences were taught by using artworks, literature, but also by referring to relevant museums’ websites, educational foundations’ websites and especially to children activities that those institutions offer.**
The students experienced natural sciences in a non-conventional way and they brought their experiences into the classroom. It was a successful process of triggering children’s imagination and creativity.

Index Terms *shadow, light, rectilinear propagation of light, multidisciplinary, natural sciences.*

I. INTRODUCTION

The present study was carried out in the 12th Primary School of Patras, the third biggest city in Greece. The school is located near the port of the city, where study 95 students. The subjects of this study were fifteen (15) students attending the fifth grade, aging from 10 to 11 years old (Law 201/1998). The control group was ten (10) students attending the fifth grade in a school located in the suburbs of Patras.

Prior the implementation in classroom of a new teaching approach, most students were unable to relate shadow’s formation with the rectilinear propagation of light. They consider that shadows are generated by people and objects. Even in much older age, pupils think that shadow “follows”/accompanies humans or objects. They believe that shadow is a lighter part of the object or that it is created when the objects conceal the light source and the existing light. Finally, many students feel that objects are followed by a shadow at all times, even in the dark.

The learning strategies used in classroom were collaborative. This teaching approach has both social and cognitive dimensions. Its implementation causes many benefits for the students. These benefits can been divided into three broad categories related to: (a) academic skills, (b) social benefits, and (c) psychological benefits.

The goal of the program was to motivate students and increase their interest about Natural Sciences, to promote a new way of learning and teaching through innovative methods such as the use of New Technologies and especially educational foundations’ websites in Greece and other countries.

II. GOALS

At the end of the course the students should be able to:

- explain the creation of a shadow as a result of the rectilinear propagation of light;
- understand that a shadow is formed when light encounters an opaque object;
- experimentally find that the size of a shadow varies per-account with object size, but also the object's distance from the light source;
- anticipate changes in the size of a shadow depending on the object's distance from the light source;
- explain how the position of the light source (including the Sun) affects the size and orientation of objects’ shadow;
- use digital resources of cultural heritage.

We also scoped to motivate students and increase their interest in Natural Sciences, promoting a new way of learning and teaching through innovative methods such as the use of New Technologies.

III. METHODOLOGY

While designing the teaching process, we took into consideration the base-knowledge of students, their skills and their expectations. Our practice was based on constructivism, where students act, take initiative, think upon their actions and finally decide. The practice was built upon the discovery learning theory as Bruner (1964) suggested, which promotes students’ motivation, creativity and independence. The students worked in groups of four of five individuals, using the cooperative learning strategies such as Brainstorming, Roundtable, Jigsaw, Think-Pair-Share, Artful Thinking.

TeachingUnit - Natural Sciences in Fifth Grade: “Light”
Number of students: 15 (9 boys, 6 girls), aged 10-11 years old.
Number of students in the Control Group: 10 (6 boys, 4 girls), aged 10- 11 years old (duration of teaching: 2 hours for both groups).
Pre-test questions (6 True-False, 3 multiple choice, 1 open).
Post-test questions (6 True-False, 3 multiple choice, 1 open).

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IV. ACTIVITIES

The concepts we focused on during the teaching process were: light and shadows. They are part of the seventh teaching unit of Physics, along with the concepts of transparent, semi-transparent, non-transparent materials, reflection, diffusion and absorption of light. During the lesson we used our two books of Physics, the student book and the activity book. We were online the whole teaching time and we used a projector so as to project images and pages from the books and the activities in the wall.

As an introduction, we watched a video from "Photodentro" about light and we read pages 72-73 from the student book. We visited the website of the American Museum of Natural History and we typed the word: "Light" in the children's activities. We learned a few things about Light and animals "That glow". Afterwards, we visited the EdMuse platform. We had already chosen some paintings that would help us introduce children to rectilinear propagation of light, such as "La vierge des palefreniers" and "La Diseuse de bonne aventure" from Caravaggio and one painting from El Greco. We carefully observed the paintings. Then, we went on to our books to complete the experimental activities, pages 129-131 in the activity book.

We projected a photograph and a sketch from the EdMuse platform as a stimuli for students to discuss about shadows. We continued to the pages 134-136, in the activity book. We talked about the speed of light and then we read a poem referring to light, written by Georgios Seferis. After that, we found a painting of Aurora in the EdMuse platform, so we started talking about the Northern Lights. Using the children's website of NASA, we learned a few things about Aurora Borealis, we saw a video from Eugenides Foundation in Athens. Finally, each students made his/her own Aurora Borealis following the instructions found in Nasa Space Place. While doing that, we watched a video by a Greek man that saw Aurora Borealis in a trip to Iceland in 2013.

In the control group we used the student's book and the activity book to introduce the students to the concept of Light and the concept of Shadows. We executed the experiments as described in the activity book (p.128-136) – the ones that were related to light and shadows – we read some information about light from the student's book (p.72-83) and we completed the unit with the post-test questions. (this is the conventional teaching process, as suggested by the Greek Ministry of Education).

V. RESULTS AND CONCLUSIONS

V.1. PRE-TEST QUESTIONS (EXPERIMENTAL CLASS)

There were 15 students who filled in the pre-test questions sheet, of whom 9 (60%) were boys and 6 (40%) were girls, aging around 10-11 years old. Before the implementation of the teaching unit "Light" 53,3% of our students believed that light travels in a straight line, while as 46,7% believed it doesn't. 53,3% of them believed that the object closer to the source of light is smaller than its shadow is. 80% didn't believe that sound travels faster than light and 60% thought that Earth is a self-luminous object. 73,3% of our students believed that shadows are created, because certain objects hide light itself. 53,3% of them thought that we must put our hands close to the source of light in order to create big shadow figures, 40% believed that we should put them far away from the source of light, and the rest 6,7% believed that it doesn't matter how far from the source of light we put our hands. 66,7% of the children said that when light meets a dark-colored surface, light is absorbed, 20% said that it is reflected and 13,3% said it is diffused.

The answers in the open-type question: "On a sunny summer day is it preferable to wear light-colored clothes or dark-colored clothes? Why? "were the following:

- *It is preferable to wear light-colored clothes to look prettier,*
- *We should wear light-colored clothes to look nicer,*
- *We should wear light-colored clothes because the sun is too bright,*
- *We should wear light-colored clothes so that people can see us,*
- *We should wear light-colored clothes because dark-colored clothes absorb the sun,*
- *We should wear light-colored clothes because if we wear dark-colored clothes the sun is reflected on us,*
- *We should wear light-colored clothes because dark-colored clothes attract the sun light and can do us harm.*
- *We should wear light-colored clothes because it is the best thing we can do in the summer,*
- *We should wear light-colored clothes because dark-colored clothes absorb rays of sunshine for a reason I cannot explain,*
- *We should wear light-colored clothes because rays of sunshine are reflected on us and therefore we don't feel the heat,*
- *We should wear light-colored clothes because if we wear dark-colored clothes their colour will disappear,*
- *We should wear light-colored clothes because if we wear dark-colored clothes light will be absorbed and we will feel hot,*
- *I don't know,*
- *We should wear light-colored clothes because it is nicer,*
- *We should wear light-colored clothes.*

60% of the students believed that the glass we use in the shower are semi-transparent, while as half of the rest believed it is transparent and the rest believed it is non-transparent. Finally, 80% of our students don't believe that the moon is a source of light for our planet.

V.2. PRE-TEST QUESTIONS (CONTROL GROUP)

10 students filled the pre-test questions sheet, 6 of whom (60%) were boys and 4 (40%) were girls, aging around 10-11 years old. Before the implementation of the teaching unit "Light", 60% of the students of the control group believed that light travels in a straight line, while as 40% believed it

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doesn't. Half of them believed that the closer the object is to the source of light the smaller its shadow is. 80% didn't believe that sound travels faster than light and half of the students thought that Earth is a self-luminous object. 80% of the students believed that shadows are created because certain objects hide light itself. 70% of them thought that we must put our hands away from the source of light in order to create big shadow figures, 20% believed that we should put them close to the source of light and the rest 10% believed that it doesn't matter how far from the source of light we put our hands. 40% of the children said that when light meets a dark-colored surface it is absorbed, 30% said it is diffused and 30% said that it is reflected.

The answers in the open question: "On a sunny summer day is it preferable to wear light-colored clothes or dark-colored clothes? Why?" were the following:

- *We should wear light-colored clothes because the light is reflected and we don't feel the heat. When we wear dark-colored clothes light is absorbed and that makes us feel very hot,*
- *We should wear light-colored clothes because if we wear black, blue clothes etc. we will feel hot,*
- *We should wear light-colored clothes because if we wear dark-colored clothes our body feels hot and we sweat,*
- *We should wear light-colored clothes because if we wear dark-colored clothes we will feel very hot,*
- *We should wear light-colored clothes because if we wear dark-colored clothes we feel very hot,*
- *We should wear light-colored clothes because if we wear dark-colored clothes our body heats up and we sweat,*
- *We should wear light-colored clothes so that our body doesn't sweat. If we wear dark-colored clothes our body will sweat,*
- *We should wear light-colored clothes because they are prettier,*
- *We should wear light-colored clothes because dark-colored clothes are hotter,*
- *We should wear light-colored clothes because if we wear dark-colored clothes we will feel hot.*

V.3. POST-TEST QUESTIONS (EXPERIMENTAL CLASS)

The multi-disciplinary approach clearly helped the students to understand better and in a deeper way the concept of "light", as shown in the students' answers in the post-test questions sheet. So, they all believe that light travels in a straight line and that it travels faster than the sound. Only one student (6,7%) believes that the closer one object is to the source of light the smaller its shadow is. They all believe that earth is not a self-luminous object and they all know that shadows are not created because certain objects hide light. All students except one (6,7%) know that when we play with shadows and we want our figures to be big we should put our hands close to the source of light. They all know that when light meets a dark-colored surface it is absorbed, so they could also explain why it is better to wear light-colored clothes on a sunny summer day. Their answers were the following:

- *We should wear light-colored clothes because they don't absorb light,*
- *We should wear light-colored clothes because they don't absorb light,*
- *We should wear light-colored clothes because they absorb little light,*
- *We should wear light-colored clothes because they absorb little light,*
- *We should wear light-colored clothes because they absorb less light, therefore less heat,*
- *We should wear light-colored clothes because we look nicer,*
- *We should wear light-colored clothes because they don't let the sun and light to be absorbed,*
- *We should wear light-colored clothes because they don't absorb much heat,*
- *We should wear light-colored clothes because dark-colored clothes make us feel hot,*
- *We should wear light-colored clothes because they don't absorb too much light and heat,*
- *We should wear light-colored clothes because they absorb light and little heat,*
- *We should wear light-colored clothes because they absorb little light and no heat,*
- *We should wear light-colored clothes because they absorb little light and heat,*
- *We should wear light-colored clothes because they don't absorb light and heat,*
- *We should wear light-colored clothes because they absorb no heat.*

Finally, 80% believe that the glass we use in the shower is semi-transparent while as 20% still believes it is non-transparent. Fortunately, they all know that that moon is not the source of light for the earth.

V.4. POST-TEST QUESTIONS (CONTROL GROUP)

After the implementation of the teaching unit "Light" in a conventional/traditional way through the school books of Natural Sciences, we noticed that although the students participated in the lesson and understood in some way the concepts they came across with, still they found it difficult to fully understand the concepts of "light", "shadow", "rectilinear propagation of light". 40% of them still believe that light doesn't travel in a straight line. Half of them still believe that the closer one object is to the source of light the smaller its shadow is. A small percent of them, 20%, believes that sound travels faster than light and one child (10%) believes that earth is a self-luminous object. Four students (40%) unfortunately still believe that shadows are created because certain objects hide light itself. They all stated that if we want to make big figures when we play with shadows we must put our hands close to the source of light. 20% didn't learn that light is absorbed when it meets a dark-colored surface but they believe it is diffused. They all said that on a sunny summerday we should wear light-

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colored clothes but they couldn't all explain why. Their answers were the following:

- *We should wear light-colored clothes in order not to feel hot,*
- *We should wear light-colored clothes in order not to feel hot,*
- *We should wear light-colored clothes because they don't absorb light and we don't feel hot,*
- *We should wear light-colored clothes because they don't absorb light,*
- *We should wear light-colored clothes because they absorb light,*
- *We should wear light-colored clothes because they don't make us feel hot,*
- *We should wear light-colored clothes because they don't absorb light, therefore they don't absorb heat,*
- *We should wear light-colored clothes because they are prettier,*
- *We should wear light-colored clothes because dark-colored clothes are warmer,*
- *We should wear light-colored clothes because if we were dark-colored clothes we will feel hot.*

Only 40% believe that the glass we use in the shower is semi-transparent, 50% believe it is non-transparent and 10% believe it is transparent. Fortunately, they all believe that the moon is not a source of light for planet earth.

VI. SELF REFLECTION

The students were excited to use the computer during the lesson and found the activities that were planned for them fun and fascinating. They requested that we should use the Internet more often and stated that it helped them stay more focused and remember better the concepts discussed. Every student participated in every activity but some of them needed a little more time to complete them.

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APPENDIX

QUESTIONS (multi-disciplinary approach)			Correct (n)	Wrong (n)
Q1	Does light spread in straight lines?	Pre - test	8	7
		Post-test	15	0
Q2	The closer one object is in the source of light the smaller its shadow is.	Pre - test	7	8
		Post - test	14	1
Q3	Does light travel faster than sound?	Pre - test	12	3
		Post - test	15	0
Q4	Is the Earth a self-luminous object?	Pre - test	6	9
		Post - test	15	0
Q5	Are shadows created because certain objects hide light itself?	Pre - test	4	11
		Post - test	15	0
Q6	When we play with shadows and we want the figures we make to be big: a) we must put our hands close to the source of light b) we must put our hands far away from the source of light c) it doesn't matter in which distance from the source of light our hands will be	Pre - test	8	7
		Post - test	14	1
Q7	When light meets a dark-colored surface: a) it is absorbed b) it is diffused c) it is reflected	Pre - test	10	5
		Post - test	15	0
Q8	On a sunny summer day is it preferable to wear light-colored clothes or dark-colored clothes? Why?	Pre - test	15	0
		Post - test	15	0
Q9	The glass we use in the shower is: a) nontransparent b) transparent c) semitransparent	Pre - test	9	6
		Post - test	12	3
Q10	Moon is the source of light for planet Earth.	Pre - test	12	3
		Post - test	15	0

QUESTIONS (control group)			Correct (n)	Wrong (n)
Q1	Does light spread in straight lines?	Pre - test	6	4
		Post-test	6	4
Q2	The closer one object is in the source of light the smaller its shadow is.	Pre - test	5	5
		Post - test	5	5
Q3	Does light travel faster than sound?	Pre - test	8	2
		Post - test	8	2
Q4	Is the Earth a self-luminous object?	Pre - test	5	5
		Post - test	9	1

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Q5	Are shadows created because certain objects hide light itself?	Pre - test	2	8
		Post - test	6	4
Q6	When we play with shadows and we want the figures we make to be big: a) we must put our hands close to the source of light b) we must put our hands far away from the source of light c) it doesn't matter in which distance from the source of light our hands will be	Pre - test	2	8
		Post - test	10	0
Q7	When light meets a dark-colored surface: a) it is absorbed b) it is diffused c) it is reflected	Pre - test	4	6
		Post - test	8	2
Q8	On a sunny summer day is it preferable to wear light-colored clothes or dark-colored clothes? Why?	Pre - test	10	0
		Post - test	10	0
Q9	The glass we use in the shower is: a) nontransparent b) transparent c) semitransparent	Pre - test	3	7
		Post - test	5	5
Q10	Moon is the source of light for planet Earth**.**	Pre - test	5	5
		Post - test	10	0

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EdMuse: the project through teachers' eye

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***Abstract*— This paper describes the activities of the teachers in Portugal connected to the EdMuse project: planning multimedia interdisciplinary lesson and working in the classroom using and reusing digital cultural resources.**

Index Terms *cultural heritage digital resources, reuse learning objects, guidelines and methodology*

How was the project seen…
First of all, it is important to mention how the EdMuse project was seen by teachers, that is, by allowing access to museological resources, from a single online platform, with the objective of motivating students to learn based on those resources, using ICT and the cultural heritage of each country involved.

Therefore, we, as teachers, are no longer forced to schedule visits – although they are important, if we are able to organize them! –, but, on the contrary, we have access to a wider range of resources and we have the chance to choose the ones which better support the educational/learning purpose that we have.

Repositories of countless artefacts, which also refer to the cultural heritage of each country, museums and their collections can thus help students to acquire and assimilate the contents worked.

Activities in Portugal already have…
Of course, not everything is new for us, in Portugal, and it seems important to clarify that, also because the analysis ahead will be influenced by this fact. So, in our country, in our schools, for some years already, we have been trying to get the students to build their own knowledge, to develop their own learning, fostering research and using ICT to do so and promoting active collaborative work between them. This allows them to a better and more complete learning environment, which try to contribute to a higher education level.

However, on the other hand, we also have a very large and heavy curriculum and lack of physical and material conditions, characteristics that, most of the time, doesn't allow that some good practices were enough to achieve better results.

What is not new to us…
So, considering all that we said before, many classes in Portugal already used a methodology where the educational activities were constructive and not scholastic, where teachers promote researches and where multidisciplinary is already a goal, giving a major role to the students, organizing their own knowledge.

This project innovated in which aspects…
However, several aspects are newer and configurate an important evolution. With the use of this platform, teachers access museums collections, both international and national, allowing them to use the best resources available, meaning, the ones who better illustrate the topics, which are previously less accessible, and they are urged to analyse the results, promoting a reflective practice of learning.

What we felt…
During the course of this project, and during the classes of the experimental group, we felt that the impact of the images collected among the museums collections, and even more the old images, were the major factor that helped the students to assimilate the topic in discussion, most of all because they are responsible to trigger the pleasure of exploration / discovery / curiosity, motivating these reactions, and also because the multidisciplinary and the effect that this had as an enrichment of the learning contributed, a lot, to a better learning.

What precautions did we have…
In order to be able to compare results and to analyse them – control group vs experimental group –, we took some cautions. So, the work on both of them addressed exactly the same content, with equal classes, both at the methodological level and in the strategies used. These cautions allowed us to isolate the factor we wish to assess – the use of the platform's digital resources.

With them, we took extra care trying not to create other differences that could influence those results, e.g., we shouldn't make the class of the control group more scholastic than normal and we shouldn't create abnormally adverse conditions.

All together, we could state the results are reliable and meaningful…

What results have we had…
Comparing the results, we found higher gains in experimental groups, but that's not all. Analysing the classes, we should refer the students involvement, which is bigger within the classes that used the digital resources. Plus we should also say that, in a way, we disclosure the

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museums and their collections and that we recognize and promote our cultural heritage, something that helped – a lot – to reach these results.

How did we built it…

Finally, it's important to say how did we work, how did we built the didactic units that we presented to the students. So, we started by analysing the Portuguese curriculum, finding the main subject, and then choosing each item to be addressed. With these topics, we access the online digital platform and search for resources that could help us to explain the contents to the pupils – and the better one, among them – working, after, how to put them together. At last, but not least, we also have to mention the multidisciplinary, worked through literature, music, art, mathematics, …, something that allows the pupils to reach several contents through a different path…

And when, like in this project, we had so much fun working and the students expressed so much interest, something we had done the right way…

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Cultural Heritage for STEAM in action

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***Abstract*— In this paper we present a summary of visionary workshops conducted in Portugal where cultural heritage was presented as a powerful motivational component. The main objective of these workshops was to introduce educators to an alternative model for learning science where components of Inquiry Based Learning (IBL), interdisciplinary and online platforms were presented in an integrated way. Teachers from all grade levels and subject domains were invited to participate.**

Index Terms *inquiry based learning, cultural heritage, interdisciplinary*

I. INTRODUCTION

There are certain common words that emerge when we are thinking of how to redesign education. For quite some time schools are shifting towards interdisciplinary with STEM (Science, Technology, Engineering and Mathematics) approach now remodelled to accommodate the art (STEAM). Thousands of articles refer to the need to put students in the centre stage and inquiry based learning (IBL) scores high when discussing how to improve learning. However, and despite of accumulated evidence that IBL works, the majority of materials found in the Internet are very theoretical and very often doesn't support educators willing to make the change from traditional methods to innovative proposals.

Having this impediment in mind the project PLATON (Promoting innovative Learning Approaches for the Teaching of Natural sciences, http://platon-project.eu) was created. PLATON is a European project funded by the European Commission within the framework of the Erasmus+ KA2 programme. PLATON main goal is to provide teachers and school communities with a coherent teachers' training framework which will update their current teaching practices. More particularly, PLATON aims to offer an open and innovative training framework to teachers of primary and secondary education which will focus on: i) promoting student-centred teaching approaches, ii) promoting a holistic interdisciplinary approach, iii) support the use of online educational tools and iv) support the meaningful collaboration between teachers of the same school.

Besides being equipped with the necessary competences to engage students in independent exploration of science and understanding what the scientific method is, it is desirable to equip them with innovative tools and resources that will enable educators to follow students individually, to personalize their lessons and proposals for classroom work to the specific characteristics of their needs. There are many such tools in the form of scenarios construction platforms, app integration, simulations etc. However, we wanted to introduce teachers to an innovative tool that allows for a graceful aggregation of all of this in a stand-alone scenario: Go-Lab (Global online Science Labs for Inquiry Learning at School, http://www.go-lab-project.eu). Go-Lab provides educators with an integrated solution where the several components of inquiry can be presented and elements for each phase embedded in a single space. The scenarios can be enriched with images, videos, online laboratories, apps etc. The offered solutions also introduce the possibility to assess students' performance while navigating through the lesson without no need to create standardized tests.

Because the learning experience should prepare students for the world of work, because learning should assume a holistic approach and be as close as possible to our reality in our daily lives, contextualized and targeting existing knowledge, we decided to adopt the EDMUSE (Education and museum cultural heritage for science learning) methodology and introduce the cultural heritage component to in-service teacher training promoted by our institution. This component proved to be the key to spark fruitful collaborations between teachers from different subject domains and across grade level. Cultural heritage was introduced as the starting point of the whole scientific research for each of the lessons produced.

II. METHODOLOGY

A strategy to reach the whole country was put in place and during the month of April 2017 a total of four events were conducted from North to South of Portugal. We called them Visionary Workshops, events where teachers are gathered to be introduced to new projects, methodologies, tools or resource and are invited to share with us their opinion about the usability and integration of the presented proposal to their daily lessons. The main objective of these teachers' gathering is to create a common vision and understanding about the proposed model and to jointly design a common vision on how the proposed action can be localized and adopted by each school/classroom/ teacher/student. Each workshop had a total duration of 6 consecutive hours.

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The workshop "EDMUSE – The Museum goes to School" had the following objectives:

1. to value the introduction of the cultural heritage in interdisciplinary, student centred, learning experiences;
2. to enhance the potential of these lessons with the use of ICT in classroom;
3. to explore diverse curriculum content and build inquiry based learning scenarios using in various phases museum digital content.

Besides these components, discussions around assessment, national and international collaboration were discussed. Participants have registered to the EDMUSE platform and had the opportunity to explore the vast collection of museum digital resources.

The workshop was designed around 3 mains components:

1. Learning inquiry based learning with "mystery boxes"[1];
2. Experimenting interdisciplinary with platonic solids;
3. Creating inquiry learning scenarios with Go-Lab.

Teachers participating in these workshops had diverse background (Natural Sciences, Physics and Chemistry, Biology and Geology, Mathematics, ICT, Arts, Language, Geography, etc.), and where coming from diverse grade levels (from pre-school to secondary).

The day started with a brief discussion on what each teacher understood as inquiry based learning and their acquaintance with the scientific method. We introduced teachers to the mystery boxes, an experiment that introduces the components of a real scientific research. They were given 7 boxes, the "mystery boxes"[51], whose content was not known. Their mission was to discover what was inside the boxes. They had to make their own hypothesis, had to develop strategies to test their initial assumptions, discuss with their colleagues their ideas and findings.

The second part was devoted to promote the creation of interdisciplinary inquiry scenarios mixing art and science. Teachers were given a series of images, from a variety of topics (cartoon characters, astronomy, biology, geology, music, etc.).

Their mission was to relate them and integrate them in a single or multiple scenario but to be implemented in partnership with the colleagues of the group. The main purpose of this activity is to overcome the psychological barrier existing when joint interdisciplinary lessons have to be created and the integration of the art component, aligned with the STEAM purpose.

The third part of the workshop, and the one requiring more time was invested in the exploration of the EDMUSE platform and the creation of an inquiry learning scenario to be implemented in schools during the next school year (2017/2018). Teachers were asked to explore the digital collection using the EDMUSE platform and choose a few components to be used in their lessons.

The lessons had the following requirements:

1. Use the IBL methodology.
2. To be interdisciplinary.
3. To use digital components of cultural heritage.

The scenarios were then drafted using the Go-Lab authoring tool, a platform that simplifies and support the creation of IBL based scenarios. Material introduced to this platform can be delivered to students by using a standalone link where the students will find all the material for conducting their research experience. The platform allows educators to personalize the scenarios for their specific needs. For instance, in some cases the cultural heritage can be introduced in the form of images in the orientation phase, the first phase of the inquiry process. Students can then be invited to use the scenario and at their own speed navigate all the different phases and conduct a research experiment where the triggering object is related to museum's digital collections.

Participants were also briefly introduced to the several apps provided by Go-Lab that are in line with the 21st century skills for students.

III. RESULTS/ACHIEVEMENTS

During the training events it became quite evident teacher's lack of familiarity with the inquiry methodology and its implementation in classroom. Their involvement in the mystery boxes activity was key to improve the knowledge about the methodology among the more experienced ones and a powerful introduction to the beginners. Knowing that IBL can be very challenging to beginners the project PLATON is developing a tool-kit that among several tools and resources, a special set of instruction are included, the "inquiry under the microscope" smart cards. A series of tips and tricks on how to conduct a lesson introducing the components of inquiry, from structured to open inquiry.

The interdisciplinary component was a bit more challenging as we were not only asking teachers to collaborate across different subject domain but also to integrate the art component in their lessons. Teachers were invited to step out of their comfort zone and to establish connections between art, their subject domain and other topics covering totally different domains.

We consider that dealing with the unexpected and the unknown in an informal setting contributes to create awareness to the fact that it is crucial for educators to step out for their daily routine in order to find new answers to emerging problems and needs, to be updated about new methodologies, tools and resources to innovate in classroom.

The art component was introduced with the use of the EDMUSE platform. It was greeted as a useful companion to the creation of STEAM scenarios.

In all 4 workshops the initial part was very motivational and several ideas on how to adapt such an activity in their schools were discussed. These activities are part of the PLATON tool-kit for teachers.

In general, the mobilization of their knowledge into creating concrete examples resulted in a qualitative improvement. In some cases the initial barrier was quickly

[1] Mystery Boxes: http://www.sciencemuseum.org.uk/educators/mystery-boxes-private?keywords=mystery+boxes

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overcome, in others some time to reflect and embed the presented model in their teaching will need some reflection and maturation. Overall the outcome was very rich and very good ideas came up.

Overall approximately 100 teachers were involved in this experience and the possible implementation of the created scenarios is foreseen for the next school year.

IV. FINAL REMARKS

Teachers participating in these visionary workshops had the opportunity to be introduced to a variety of possibilities to innovate and renovate their daily lessons. In a user friendly way, they had a first glimpse of the power of IBL and the many possibilities they can explore while collaborating with other colleagues.

The most impactful component was the realization that our cultural heritage can be a very powerful component for integration of several areas of knowledge. It can be used as orientation for specific topics, as inspiration to active investigation, to reflect on various social/cultural/historic aspects and as such be an important starting point for several research experiences.

ICT skilful teachers worked alongside ICT beginners and the excitement could be felt equally in both audiences. Nearly 100 teachers were reached and the promise of further training is now the next chapter.

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Evaluation of teaching results of the EdMuse learning approach

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***Abstract*— This paper tries to summarize the teaching results of the learning process followed in various classes of the age groups 8 to 12, at the three countries which participated in the EdMuse project. We are going to report our methodological approach and the theoretical background that dictated them and then we are going to present the teaching results and their comparative analysis.**

Index Terms *learning process, teaching results, educational tool, multidisciplinary lessons*

I. INTRODUCTION

The EdMuse project was implemented in the context of an Erasmus+ project with the participation of educational and cultural organisations of Italy, Greece and Portugal. Its main goal was the design and implementation of a methodological path and a digital tool in order teachers and students to use and reuse easily and fairly the cultural heritage in the didactics of natural sciences. Under this perspective the partners adopted the theory of constructivism and the multidisciplinary approach in order to form teaching processes in which they used digital resources through the EdMuse platform. The teaching results were transnationally very encouraging.

II. THEORETICAL BACKGROUND

The Natural Sciences Didactics and the Museum Education followed a common theoretical process, passing from the behaviorism to the social constructivism and more recently combined to socio cultural approaches. That process effected the Natural Science Curriculums and the Educational Programs of the museums which changed their focus from the "subject" to the "learner". [1]

Nowadays the common ground between museum education and Didactics of Natural Sciences is the theory of constructivism. The educational theory of constructivism considers that students construct knowledge themselves, through social interaction and language use, and they interpret the various concepts and ideas through their personal models, which are concept constructions, widely known in natural sciences didactics as conceptual representations. Constructivist educational theory argues that in any discussion on teaching and learning we should focus on the learner and not on the subject to be learned. The main teaching goal on Natural Sciences Didactics is to help students to learn how to learn, through multidisciplinary approaches, immediate experience, use of original resources and interactive intitatives.

The "hands on" and "minds on" activities of Dewey, the theories of Vygotsky and Bruner, which highlight the role of cultural background on learning and the theory of multiple intelligences of Gardner, converge on using museum education in order to design and implement multidisciplinary teaching approaches. [2]

III. METHODOLOGY

The chosen methodology included two classes, an experimental class and a control one. Teachers applied the same pre and post tests in each class, which includes one multiple choice question and an open one. At the experimental class was followed a multidisciplinary approach with the use of the EdMuse platform. The control class followed the traditional approach of each country. We worked with three age groups, eight to nine, ten to eleven and over twelve. The subjects concerned, water, weather, solar system, light and Galileo's telescope. The teaching results came up through a two level comparison. We compared the right answers of the pre and post tests in every experimental and control class of every country in order to record the percentage of possible improvement. Then we compared the percentage of improvement among the three countries at the various age groups.

IV. TEACHING RESULTS

The majority of the participating classes in all countries recorded significant improvement after the multidisciplinary lesson, higher than the control classes. In individual cases that the above didn't happen were standing special circumstances, concerning the cognitive level of the experimental and control class. More improvement was recorded in the age group eight to nine. We have to highlight the common result of great improvement especially on difficult concepts. The summary of the teaching results are shown in the following tables:

TABLE 1. AVERAGE IMPROVEMENT

	Experimental Class %
Greece	15
Italy	10
Portugal	13

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TABLE 2. IMPROVEMENT PER AGE GROUP

	Experimental Class %		
	Ages 8-9	***Ages 10-11***	***Ages 13+***
Greece	**18**	**20**	**9**
Italy	**25**	**13**	**19**
Portugal	**18**	**10**	**10**

V. CONCLUSIONS. FUTURE PERSPECTIVES

The evaluation of EdMuse's project teaching results were very encouraging. They suggested the need for further use of multimedia in teaching and furthermore they stressed the effectiveness of the use of cultural heritage resources in Natural Sciences. We consider that the EdMuse platform, due to its firm theoretical and methodological background, its functionality and the fact that it was tested transnationally, in real class conditions, is able to become a valuable educational tool.

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Proceedings

The School Museum as an educational pathway

The experience of Università del Molise

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***Abstract*— In 2006 the Documentation and Research Centre for School History, School text and Children's Literature (Ce.S.I.S.) has been established at the University of Molise. This very interesting structure, committed to the research on historical-educational topics, was complemented in 2013 by the Museum of School and People's Education, devoted to the preservation of historical-educational heritage and conceived as an ecomuseum.**
The Museum has so far designed and implemented a number of initiatives that involve the active participation of adult and young visitors, whose finality is to complement formal school programs, as well as offering a set of educational proposals for families. The Museum operates in synergy with universities, schools and territorial entities through the design and implementation of shared educational pathways. The Museum also participates to the ongoing internationalization process.
We hereby intend to illustrate the museological character of the initiatives proposed and to describe the activities developed in the past few years. The contribution will illustrate the different types of laboratories proposed: history teaching laboratories based on the use of documents, reading laboratories exploiting the use of the literary books that are part of the museum's collection, digital resources laboratories, hands-on and multisensory laboratories.

Index Terms *history didactics, museum of school, cultural heritage, ecomuseum, participatory method*

I. PREMISE

One of the main objectives of school museums today is the discovery of the historical, cultural and didactic value of the heritage connected to education.

The very existence of a School Museum witnesses how relevant and connected is the history of School to the study of institutional policies and the social and cultural dynamics today as it was in the past.

School documents and materials are cultural assets that are able to reconstruct a collective history and provide at the same time a place of conscious repossession of the past and education to citizenship[1].

Fig. 1. School Museum exterior
(Residenza Univeritaria Vazzieri-Unimol – Campobasso, Italy).

II. THE BIRTH OF CE.S.I.S. AND SCHOOL MUSEUM

The birth of Ce.S.I.S. (2006) and of the Museum of School and People's Education (2013) goes hand in hand with the evolution that the educational historiography has lived in the past 20 years. Moving from the suggestions that, ever since the 1990s, the European historiography of French, Spanish and later British and Italian inspiration has offered to scholars, with respect to the concept of material and immaterial school culture, it was possible to start a specific reflection even in the field of the educational / historical heritage [1].

[1] This article includes a partially modified version of my contribution published in Spanish language: "Museo della scuola e dell'educazione popolare Università degli Studi del Molise - Campobasso, Italy" with Michela D'Alessio and Alberto Barausse, Cabás, n. 16, December 2016, pp. 143-167.

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Fig. 2. School Museum interior.

The changes introduced by the new historiographical perspective [2] [3] [4] have also posed the issue of the conservation, collocation and exploitation of the "material and immaterial objects" within the perspective of Cultural Heritage [5]. The text books have been sided by new educational object typologies such as notebooks, school records, teaching supplies like wall boards or scientific tools, along with images, music and oral evidences. This new focus on school objects has brought to the exploitation of the collections that today represent an important part of the historical / educational pathway.

III. THE MUSEOLOGICAL DIMENSION

The structure that we have intended to promote aims at incorporating the most recent reflections coming from the studies on educational museology [6] [7] [8]. The project started at Unimol has the twofold aim to cooperate with the educational offer reserved to teachers and to serve the so called "third mission" of Italian universities. On the one hand the teachers, through the fruition of the historical pathway inside the museum, can rediscover the cultural origin of their profession and at the same time get trained thanks to the new teaching experimentations that take place therein. On the other hand, the museum intends to develop a close collaboration and interlocution with the territory and the local community, following the model of "ecomuseum" whose most evident feature is the evocation of the territory, so that the historical contents of the School Museum are represented even outside the mere physical space. The contents of this museum typology are part of a broader reality: the "school" is present pretty much everywhere on the territory, not only in the very school buildings, but also in school archives, abandoned schools, and in all those places that in the past served as schools, like private households, board schools, even the very roads that used to take the pupils from their homes to school (especially country or rural schools).

According to this project idea, the museum is described as "an action carried out by a community for the sake of its development, starting from its own heritage" [9], which differs from the traditional idea of museum. The first exposition hall witnesses the active involvement of people who decided to deposit, lend or donate their own school objects and documents: these memorabilia have become, like that, a significant part of the collective memory but, especially, they have turned into "semiophores", that is to say the bearers of invisible meanings [10].

Fig 3. Section devoted to school material culture.

The School Museum, established in 2013, is located inside the University Campus of Vazzieri. The collection kept inside the Documentation Center counts about 5000 units. The museum's set-up responds to the finalities mentioned above; it is structured into five sections: three of them follow a chronological order, that starts from the Unification of Italy (1861) until the present day, all through the fascist and republican era, with a focus on the national and local reality.

The other two sections have combined a synchronic and diachronic dimension, by focusing the attention on school materials and protagonists. A part of this exposition is dedicated to the reconstruction of two small classrooms dating back to the first part of the 900s, from where it is possible to observe how the physical space was organized and what tools were used. The exposition is completed by videoclips and other multimedia devices showing interviews to old teachers, vintage images and projections of educational objects kept in the museum, and ipads from where it is possible to browse old textbooks and copybooks.

The methodology used aims at favouring a critical approach rather than just emotional: the experiential past is contextualized into a precise historical moment, and this operation allows the transformation of the mere personal memory into a shared collective memory.

IV. DIDACTIC OFFERS AND PARTICIPATED FRUITION

The initiatives proposed develop around the principle of "open museum", which is based on the fruition and exploitation of the collections in close cooperation with the users, so to give a

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dynamic perspective and a participated approach to the idea of school and education. The School Museum wants to be a place where the Community can reflect upon and build a more conscious idea of citizenship. The School Museum is not just a collection, but a landmark for the citizens who want to rediscover their own past as pupils from a historical perspective.

Based on this foundations, the Museum has designed and proposed initiatives that require an active involvement of the users, not only teachers and pupils, but also entire families.

The simple illustrative approach has been enriched with elements of action and exploration [11].

Particularly significant in this respect is the intergenerational approach of the didactic offer, which can be seen in initiatives that require the joint participation of elderly and children.

The lab activities of the School Museum are designed by experts, tested with the public, evaluated and eventually fine tuned for a future replication; this process guarantees, at the same time, not only a higher degree of quality but also to maximize the resources available thanks to the replicability of a successful initiative with the same materials and resources.

Fig 4. Reconstruction of a classroom.

The labs can be divided into different categories, according to their contents and methodology used:

HISTORICAL LABS: The design of this kind of labs follows the idea that history cannot be learned in a passive way but through historiographical operations of reconstruction through the use of particular documents and tools.

The School Museum offers a variety of such materials like for example school records, school essays, ministerial notes, textbooks, notebooks, pictures, video clips.

EXPLORATORY LABS: through a series of clues and blank maps, the participants' task is to reconstruct the history of school by working on the memories of old teachers. In order to do that, pupils must consult different types of sources to find the missing tiles.

Thanks to this "exploratory method", the participants can develop museographic notions and orienteering abilities inside the exposition.

Fig. 5. Middle school pupils during an educational lab.

READING LABS: these labs have been particularly successful so far: assisting to the reading and presentation of children's books has brought the young participants to understand and love both the classics from the 800s and 900s that are part of the museum's collection, as well as the most recent literary offers.

Fig. 6. Reading lab in the School Museum.

HAND-ON LABS: participants can use writing devices from the XIX and XX century kept in the museum and to engage in calligraphic operations and writing techniques.

MULTISENSORY LABS: poetry, music, hand-on activities are also joint together to allow a more complete fruition of the initiatives proposed in the Museum.

The final stage of the activities is dedicated to debriefing, through a guided reflection on the experience lived and the notions acquired, aimed to investigate both the emotional and cognitive impact developed by the didactic operation.

V. CONCLUSIONS

The didactic process has been monitored through tests of different types; in a self-evaluation test, the children were

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asked to evaluate their attitude as to the lab dynamics, the level of group integration, and the skills used.

Other types of test were administered to teachers and pupils, for an evaluation of the activities: hereinafter are reported some interesting results coming from questionnaires where the answer type was: 1 (not at all) 2 (a little) 3 (enough) 4 (much) 5 (very much).

For what concerns the questionnaires to the teachers, the following rates were recorded:

- Do you think that the lab activity was useful to the children's personal growth? The answers were 4 (75%) and 5 (25%).
- Do you think that the material used is suitable to the pupil's skills? Answers: 3 (13%), 4 (50%), 5 (38%).
- Would you repeat the experience? Answers: 4 (25%) e 5 (75%).

After the didactic process, teachers have reported how this kind of learning experiences remain impressed in the pupils' memory, as they involve not only the cognitive, but also the emotional side. At this respect, this is what a pupil said: "Thank you. An unforgettable experience" (Grazie, una esperienza indimenticabile) [12].

Fig. 7. Didactic lab with kindergarten pupils.

These experimentations and experiences had the objective of offering an overview of the work of the Museum's didactic section, highlighting the attempt of tracing a path where the historical research meets the didactics of history and of cultural heritage [13] [14] [15], together with a well-targeted use of Children's literature. The School Museum aims at being a "dwelled place" that belongs to its public and interacts with it. The museum visitors, through these experiences, become active participants, conscious users and the builders of their own cultural and educational path.

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Education through co-creation:
the participatory museum proposals of the Mu.Ve.Re. network Musei (Scientifici) Veneti in Rete

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***Abstract*— "Mu.Ve.Re.-Musei (Scientifici) Veneti in Rete" is an user-center network project among the scientific museums in Veneto Region. Recent studies on museum audience have revealed the gap still existing between institutional proposals and the interests of Millennials, stubborn to top-down educational methods, which are considered (wrongly or reasonably) far from their real interests. In the belief that young people are not insensitive to the value of the museum heritage, but that it has often been communicated with inappropriate tools, Mu.Ve.Re.**
proposes a participatory approach to cultural heritage, with a language and dynamics close to new generations: social networking, gamification, digital technologies, and especially active involvement in all phases of communication and promotion and also in the creation of textual and visual content, shareable with other visitors on a virtuos (and sustainable) circuit. The person's interest in the museum heritage is enhanced by his direct involvement in its valorisation: the ability to create personalized content based on his skills or on his educational needs gives the visitor a great satisfaction, encourages him to increase his knowledge of the museum and to share his experience with his friends and with others curious. In this way, the true mission of the contemporary museum is enhanced: it is not just a place for conservation, but also for the knowledge sharing and creating and for the experimentation of smart social relations.

Index Terms *participatory museum, audience development, gamification, museums and millennials*

I. INTRODUCTION

Museums have been engaged in a deep rooted overhauling of their institutional role and public image for some years now in favour of a dialogue-based and variable approach to a user base which is increasingly aware of themes such as personalisation of provision, cross-media interaction and, lastly, active participation in the context of a recognisable 'brand community' [1]. Digital technologies and social web platforms play and will continue to play a significant role in encouraging active user participation at an educational and creative level [2], but the key to the promotion of forms of participation capable of creating new synergies between the various subjects involved is principally a matter of a radical change of attitude. We need to move on from cultural messages in authoritarian educational form modulated according to a nineteenth century pedagogy (demagogy) on which many contemporary museum formats are still based, to a model based on dialogue, critique and, with an awareness of the risks [3], open to bottom-up interpretation opportunities and thus ready for the challenge of experimenting with new models of using, educating and socialising museums.

More than ten years on from the first digital platform precursors promoting a new partnership relationship between museums and their users, it is now possible, abandoning now clearly failing proposals, to set out best practices on which original participatory museum projects can be founded which are sensitive to the diverse demands of individual institutions or, in our case, museum networks.

II. SPECIFIC AND CRITICAL ISSUES AT THE MU.VE.RE. MUSEUMS

The Mu.Ve.Re. Network (an University of Padova's FSE research project funded by the Veneto Region; project manager: Laura Guidolin; research team: Marta Bellio, Chiara Marin, Dario Marinello, Federico Rizzato) currently covers 11 university museums belonging to Padua University, 5 provincial museums and a diocese museum. They are medium-small scale museums managed differently, but sharing certain specific issues – in particular a scarcity of resources which translates into a difficulty experimenting with ongoing supply of services which differing from basic conservational roles, though on different scales in accordance with each museum's primary functions – and also a profound bond with their local areas, which constitutes an important launch pad for initiatives designed to promote citizen participation and enhance the cultural heritage as an element of growth, including economic [5], for the whole community.

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For the purposes of a 'smart and sustainable' promotion strategy for the network's extraordinary patrimony, a range of stakeholders from the school, research, advertising and tourism worlds have been brought into to a participatory role alongside museum managers. The brief showed a clear gap in the communication of the regional cultural offer, due to the massive fragmentation of proposals (entrusted to individual museums, provincial administrations, cultural associations or educational institutions) and also to a general disregard for public analysis: consequently, heritage communication has often failed to intercept user needs and requests. [6]. The elaboration of a participatory museum project extended to all the members of the Mu.Ve.Re network seemed to be successful in responding to the different needs of promoting and enhancing cultural heritage and ensuring continuity in the field of education from the school-university environment to the museum's one and to the whole territory: through an unique engagement proposal it is in fact possible to strengthen the sense of belonging to a transversal and trans-generational community, that is self-recognized by the common interests of its members and promotes a multi-directional exchange of skills and knowledge."

III. THE MU.VE.RE. INFRASTUCTURE

The starting point to the Mu.Ve.Re participatory museum proposal and the convergence point for the various initiatives undertaken both online and offline is its portal: alongside a static IT section ("Museums"), three dynamic sections are planned ("Collections and Insights", "Itineraries and Trajectories" and "News and Events" dedicated to educational and professional opportunities and appointments) in which, once registered, users can upload their own contents.

The "Collections and Insights" section hosts photographs, texts and videos relating to a specific cultural institution and the exhibits kept in it. User generated contents are channelled to specific museums and collections by means of a 'flag' system which contributors are called on to select every time they upload insight photos or documents. 'Tags' can also be added to contents generated by other users or extrapolated from pre-existing databases for each collection. This system encourages interpretations of exhibits which are not overly academic in nature as this can frequently discourage the less expert from tracing objects or works of art on the web whose scientific denomination they are not familiar with [7], to achieve a folksonomic classification type [8] useful to museum operators adopting a unbiased view of their collections, and to visitors, encouraging them to feel part of the museum when they receive a recognition of individual skills and know-how in exchange for videos and posts.

To foster engagement of the teenage target group, elements from gaming such as goals, prize systems and recognition of progress by user communities have been introduced [9]. As in well-known online platforms such as *Duolingo* or *TripAdvisor*, those taking part receive visual confirmation on each completed action and accumulate 'badges'. As well as feedback, this performs the function of social testing grounds because badges can be made visible to other users on the more widespread social networks too and, hinging on comparison and imitation dynamics, serve to reinforce involvement [10]. Completing and collecting 'achievements' guarantees users a series of awards calibrated in such a way as to stratify experience by grade, length and continuity of effort required, ranging from straightforward belonging (*status*) to a Mu.Ve. Re. Community, to opportunities (*access*) to privileged interaction with curators or to obtain exclusive invitations to openings and vernissages or copies of individual museum publications, to access to exclusive functions (*powers*) such as fixed term management of one or more Mu.Ve.Re. social profiles and the chance to take part in temporary exhibition creation [11].

The "Itineraries and Trajectories" section enriches the participatory experience introducing co-operation and storytelling factors. Visitors can access a series of visit proposals extended to multiple network museums or other points of interest in the local area – in a process of externalisation of the museum experience which is fundamentally important to the promotion of sustainable 'travel' –, which they can use simply as an aid with which to plan their itineraries, but also to vote, comment and share or contribute to implementing and suggesting other stages or insights. The engagement level required of users is progressive in order to enable visitors first to familiarise themselves with the system and then gradually to perfect their use and receive recognition for their efforts. Following Nina Simon's suggestions on the importance of providing clearly defined co-creation limits [12], newcomers are allowed to experiment with active participation in a straightforward play mode in which they are asked to complete an itinerary by selecting a date from the alternatives provided: the goal is not to test individual know-how (there is no right or wrong answer mechanism), but enabling each user to personalise their experience and feel part of a community. On the next level, visitors are called on to take part in itinerary or themed proposal completion in an autonomous way, using the contents already present on the site or uploading new ones. An upper limit is imposed on the contribution that each individual user can make to a specific itinerary in order to ensure the creation of multiple voice stories and incentivise participation. 'Emotional rewards' are thus added to the prizes examined above, linked to the "intrinsic satisfaction generated by the system such as the pleasure involved in moving forward or sharing experiences with someone" [13]: even when simply uploading a photo or brief caption, users are creating something which did not previously exist, telling a new story and, ultimately, narrating to others. All those who take part in the completion of a narrative get a special badge which rewards them for the effort made to work in synergy and contribute to moving it on a level. This motivates the most active contributors to seek out new partnerships and co-operative activities personally to complete the largest number of narratives possible. The last level allows senior contributors to present their own itinerary or trajectory and invite other users to take part in completing it.

All three sections use default settings relating to the last contents created and those most voted, but targeted research can be done by locality, type of visitor, subject area involved and so on, by means of 'tags'.

Access to Mu.Ve.Re. functions can be completed on the site or in a responsive way through the app, integrated with a QR-

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Code recognition system. As compared to other interactive technology, like beacons, the QR-Code choice was a smart solution: it is accessible to institutions with relatively few financial resources and is more familiar to a wider range of users.

IV. CONCLUSION: MU.VE.RE. 4YOUTH

By means of its participatory structure, Mu.Ve.Re. aims to intercept demands for personalisation, relation, sociality, critical comment and hands-on experimentation, which studies brought out as inherent to the so called young 'non-public' [14]. By offering an alternative to the pyramid educational model Mu.Ve.Re., with its wealth of stimuli, emotions and opportunities for individual expression and affirmation, encourage people to acquire and strenghten new skills, which can be of use in their future working lives – also thanks to the "Resources" section, which refers to webinars and tutorials for the use of new technologies in cultural communication, on the model of "StoryTelling Toolkit" by Museweb Foundation [15]. The Mu.Ve.Re. educational initiative goes beyond traditional subject boundaries to present museums as places in which knowledge interweaves and is shared, in which experience can be gained with peers, in which the values underlying the community – not because they are set in stone but as experienced and implemented via personal critiques – can be recognised, conserved and passed down from generation to generation (i.e. Museum Definition by ICOM). By means of this historical redefinition process, museums assert their plural narrative vocations as the only ones capable of unmasking information distortions and restoring their 'importance' in the present too, i.e. teaching the citizens of tomorrow that by rethinking objects, experiences and ideas we can build a different world from that depicted in dominant cultural discourses, one which is accessible, open to dialogue, tolerant and sustainable, a 'young' world.

To date, Mu.Ve.Re. infrastructure was made available only in beta mode and was tested by a limited number of volunteers, who were entrusted with the task of evaluating the experience both in terms of ease of use and of the degree of engagement generated: by treasuring their own feedback, we made adjustments to the platform implementation features and to the system of achievements, which we also introduced for "basic" participation interventions, such as voting and sharing content already on the site. Test participants gave a generally positive impression of the experience, judging the Mu.Ve.Re. platform as a useful tool for involving young people, both for its social dynamics and for "challenge" components with, which encourage the learning and the strengthening of knowledge yet acquired in a playful way. In September 2017, Mu.Ve.Re. will be presented to regional stakeholders, thus initiating tightened collaboration with educational institutions and training centers.

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Technoscience as heritage in the classroom

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***Abstract*— The heritage of the Technical University of Denmark (DTU) is not easily explained. There is a real temptation to blackbox the technology in itself. The History of Technology division is exploring ways to keep the box open and translate the workings of the technology and the explanations of the scientists. A study of the process of emergence, spread, impact and perhaps closure of the technology Flow Injection Analysis has been undertaken. It a story of multiplicity and it takes many twists and turns and includes a lot of difficult science. We decided to find a way to bring this story into the high-school classroom. The FIA technology is explained by letting the students explore and use a specific FIA machine in a virtual lab. We also wanted to introduce the findings in our historical exploration of FIA. This is done by telling the student several different narratives relating to FIA or other historical technoscience developments. The students work through one or more scenarios and make decisions and debate. Our theory was, that they would use some of the apparatus they have gained from the narratives in the decision making process. In this talk I will revise the outcomes of this process.**

Index Terms *Virtual lab*

I. INTRODUCTION

The Technical University of Denmark (DTU) actively collects it's own heritage and has a wonderful historical collection full of fantastic stories. The History of Technology group at DTU aspires to use this collection in communication products for general audiences. But most of the collection is very difficult to explain. It is tempting to just tell the compelling narratives and leave out the difficult ontology of science and technology. However, ontology is important in the stories and we are exploring ways to keep the blackbox open.

This paper will describe a specific project based on a chemical platform technology called Flow Injection Analysis (FIA). Previous to collecting material from the development of FIA technology for the historical collection, we had not heard about it before and we had some difficulty getting our heads round it. In this paper I will not attempt to explain what FIA is except saying, that the development of FIA was clearly a story about technoscience. Hence in FIA science and technology are deeply intertwined and develop together. It is impossible to say where one starts and the other ends. A historical study showed that FIA had a role in history of the modern world, but it did not have a simple correlation to everyday life or the great narratives of our modern world. But if we estimate the significance of a technology by use, as recommended by Edgerton [1], FIA is important. Two features made us pick the FIA technology for an interpretation project. It had a somewhat interesting narrative about humans and the prototypes were made from Lego. The Lego was recognizable to all observes and could perhaps work as a boundary object [2] between the technology and the audience?

II. GOING DIGITAL

We decided to aim for an online digital product for high school science classes and the whole thing should take place in the classrooms at schools. Being online would give our product a large reach as the schools would not have to travel to take part. Working in a classroom meant that the pupils could concentrate more than in an exhibition. A high school level audience was also highly attractive for our home university. Hopefully, our product would help raise the interest in our university. It became our ambition to create an engaging product, which would entice the youngsters to take part. We decided on gaming format. Computer gaming is very popular with this group and we wanted to tap into this.

III. MANAGING AND MESSAGES

We started to develop the product, a funding plan and the design team. We involved a professional developer of science communication products for high school. The developer helped identify and sharpen our main messages and she took the role of production and administrative manager, leaving the history group to what we did best – content.

The interpretation product should do several things. It had to communicate the results of a historical exploration of the FIA technology as well as explain the science and technology behind FIA and show the application of FIA. The historical study showed a process of emergence, spread and absorption of the FIA technology, but also a scientific theoretical development as part of the process. Trying to cover all this, the history group made a long list of messages, but the developer told us in no uncertain terms to cut it down.

We also set overall aims of the interpretation:

1. Explore ways to express the explanations of the scientists of how they perceive the knowledge and/or technology. 2. The history and heritage from DTU points to multiplicities in stories of the processes of science and technologies. We will explore ways to express these multiplicities. 3. Explore ways

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to inspire the audience to think for themselves. Which tools helps them? 4. Explore ways to place history and heritage into new places. 5. Explore ways to co-produce with actors who took part in the original events. What can we co-produce? 6. Explore the outcomes of the process and audience experiences.

IV. CURRICULUM RULES TYPE

High school has a demanding curriculum and high school teachers only choose to use teaching material, which delivers on specific parts of the curriculum. We chose to target chemistry teaching in the second and third year and the history of technology subject, which was taught at technical High Schools. To ensure that our product would fit classroom needs and practices, we developed the product together with high school teachers, who were offered pay for the work. We considered teachers as an important target group. They had to choose to use the product and in our final product we made great efforts to explain how the teachers can use the product and which parts of the curriculum it covers. Staying within curriculums had implications for the overall design of the product. The history group had hoped to integrate the history content and science content completely, but this was abandoned. It would be very costly and it would not fit with the high school curriculum. Instead, we made a virtual lab with a short historical introduction and a separate history and sociology part.

V. DESIGNING THE VIRTUAL LAB

In the virtual lab the pupils would use the FIA technology. We used the software company Labster, which is experienced in making game style labs for high school teaching, such as a CSI lab for genome sequencing [3]. Labster has a lot of standard code, which keep costs down.

It was our ambition that the application of FIA technology in the lab should be based on a real life application and be connected to an issue, which would interest high school students. In the search for an application the history group involved scientists, who had developed or used FIA technology. However, struggling to understand the level of theoretical knowledge of this specific audience, most suggestions from the scientists involved very difficult theory. After a lot of searching and considerations we used a study of caffeine content in different foods, a substance which is well-known and consumed daily by many Danish youngsters. Again caffeine was a boundary topic, which would give the students a familiar anchor in dealing with a very unfamiliar technology. To our disappointment the caffeine study only used parts of the FIA technology, but it was manageable within the curriculum. It was close enough to highlight some key points.

In the lab the students were to test the caffeine content in different foods using a FIA-method and analyze the results. The pupils also went through the principles of the FIA-method, acquired knowledge of the substance caffeine and the effects of caffeine. Along the way the pupils got points depending on how well they solved the tasks.

An experienced science teacher wrote a draft of the theory, questions and exercises, which the pupils would solve on their way through the lab. The developer reworked the text in collaboration with the teacher. Text and exercises would appear on a lab pad as the pupils went through the lab and the students could also consult the theory text whenever they wanted. On the lab pad we used multiple choice with four possible answers. The answers reshuffled if the students picked the wrong answer and the students achieved fewer points with each click on wrong answers. We had hoped to make a simulation allowing the students to assemble a FIA-instrument using Lego-bricks to create a connection with the prototypes in the historical collections. But this had serious copyright implications and was abandoned.

VI. TESTING THE VIRTUAL LAB

The lab was tested with three separate groups in the setting of their own classrooms. We observed while the students worked through the lab experience and at the end they filled in a questionnaire. The first tests divulged many issues. Some issues were shared by many users, but the students also had individual experiences. An animation which made perfect sense to one student was difficult for another and according to the teacher this was not just a matter individual academic abilities. Individual learning styles could also be at play. The animations are very visual and this will not fit all learning styles. A general issue was, that the product had come to close to book learning on a screen. We needed to add more of the feel of struggling with a technology in a lab, which was what we felt that the digital product could add. Having rewamped the lab, another test run was carried out and a lot of issues appeared to have been resolved.

During the tests we paid close attention to the effect of giving points, which was believed to add a feeling of playing a game. The competitive issue of point giving appeared to appeal to some students, who according to the teacher were far more motivated than in a normal setting, while others found it annoying or meaningless. Generally our observations and the questionnaire showed that the students were motivated by the virtual lab, intuitively understood how to use the lab and achieved a good understanding of the technology and the science through the animations and explanations.

VII. HISTORY

After a host of deliberations we decided to work with the history part in a very different way. The historical study had revealed very complex developments. The history group wanted the students to explore the multiplicity of the FIA story and the processes involved in technoscience as well as provide the pupils with tools to analyze technoscience. The history group had a great many messages, but the developer helped us cut the massive list down to five focus areas. We wanted the pupils to debate and contemplate dilemmas. We hoped, that dialog would stimulate cognitive redefinition [4]. We chose to focus on ten specific topics and wrote ten short narratives for the students, a fictitious case and a role play. To support the process we also made short videos of experts lecturing and a short intro text for the students. The texts were kept very short, as the pupils should be able to read them in class. The text was

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formulated in everyday and colloquial language. We also produced a short plan for the teachers. In the teaching plan we recommended that all pupils read the case focused on FIA as it introduced some central concepts together with the background text. The other narratives feed on well-known technologies or scientific discoveries [4]. We recommended that the teacher would then pick a couple of cases that the students would work through in small groups. The pupils were asked to identify which of the five focus areas characterized the case. All cases were accompanied by a few questions for the students to contemplate.

VIII. A TEST OF HISTORY

The history part was tested with around 25 students during a history of technology class in a technical high school. We were very interested to see if the students would be able to read and understand the texts in class and if the texts offered enough info to allow discussions. We were very happy to observe that this seemed to be the case. The students had very good debates using the focus areas. The dilemmas appeared to inspire them. We also wondered if we were steering too much. There is a serious ethical issue in presenting a complex story as a simple question dependent only on a few features of our world [4].

But the students showed great ability in going beyond the information provided in the texts. Listening in on conversations, it was quite clear that the students were able to think for themselves. Dilemmas appeared to be a good tool.

Our hope was that teachers would use both the virtual lab and the history part together. However, our two science teachers seemed somewhat uninterested in the history part and the history teacher was not interested in the chemistry. Also, a meeting with two other history teachers gave us the same feel. We were not able to test this and have not learned of any experiences using these two parts together.

IX. WHAT DID WE LEARN?

We had set a number of aims for the FIA product. We did find a way to express some of the explanations of the scientists, much helped by animations and simulations. But this had to be adapted to the high school curriculum. In the history part the students clearly got the multiplicities in the stories.

They were also clearly inspired to think for themselves through the dilemmas but also to use the tools given to them. We only partly manage to place history and heritage in new places as then only made cameo appearances in the virtual lab. The scientists did co-produce with us, but they were demotivated by the constraints of the curriculum.

Do the students learn more in the virtual lab than they could through book learning? The answer to this is yes. The digital animations are great tools for learning and the students could do work which would have been impossible in a school lab.

A team with different skill-sets proved important. It helped the project stay on track and keeping focus on the audience.

Historical material did play a direct role, but mainly through images. Historical objects were shown, but did not play a significant role.

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The collections of the Italian University Museums

Network for an education to scientific method through the use of new technologies

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***Abstract*—The museums of 10 Universities of the Italian University Museums Network (Bari, Chieti-Pescara, Florence, Ferrara, Modena-Reggio Emilia, Pavia, Perugia, Rome La Sapienza, Siena, Tuscia), with the addition of two important museums (the Civic Museums of Reggio Emilia and the Regional Museums of Natural Sciences of Torino), coordinated by the University of Modena and Reggio Emilia, realized several educational paths for the guidance to scientific method and culture. These paths, aimed to create contexts for non-formal and informal learning, can integrate and innovate the standard techniques of formal education. With this purpose, three main themes have been chosen and then conjugated in different specific sub-themes: Biodiversity and Agro-biodiversity, Color (in Nature, in Art, in Physics), Time (Geology and fossils, Human evolution, Time measure, Time in Physics, Evolution of the Antarctic). The paths, including experimental labs, are addressed mainly to secondary schools students but also to younger students, having experienced that they are mature enough, still very receptive, and willing to deal with an intense cognitive engagement. Each path is presented on the Network's web-portal thanks to: a path's sheet, a conceptual map, bibliography, images and videos and deepening materials (www.retemuseiuniversitari.unimore.it). On-line evaluation surveys will be administered to teachers and students, in order to detect strengths and weaknesses of each path's different components –planning, execution, participation– and work on targeted improvements. Along with this experience, the museums of the Network are realizing valuable initiatives in the framework of the 'Alternanza Scuola Lavoro' (work-related learning), in which the specific didactics developed by the projects of the Network is used to shape programs that effectively engage students in work-like experiences with a reference to museum activities and professional profiles.**

IndexTerms *guidance, scientific method, non-formal learning, informal learning, transdisciplinary*

I. THE PROJECT

The museums of 10 Universities of the Italian University Museums Network (Bari, Chieti-Pescara, Florence, Ferrara, Modena e Reggio Emilia, Pavia, Perugia, Rome La Sapienza, Siena, Tuscia), with the addition of two important museums (the Civic Museums of Reggio Emilia and the Regional Museums of Natural Sciences of Torino) and coordinated by the University of Modena and Reggio Emilia, realized several educational paths for the guidance to scientific method and culture for a second project approved and funded by the Ministry of the University and Research in 2014, in the framework of the Law 6/2000 for the dissemination of scientific culture (www.pomui.unimore.it).

Fig. 1. The Italian University Museums Network.

The ultimate goal of the project is to transmit to students, trough museum visits and laboratorial experiences, the accuracy of the scientific method which underlies every discipline. It is indeed necessary that students understand how the evaluation of researcher is subjected to a precise, replicable and comparable acquisition of data.

The Networks' Museums have debated about training models and the more effective methodologies in order to

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provide specific knowledge both of the different disciplinary fields, represented by the variety of the collections, and in a trans-disciplinary perspective, seizing the opportunities provided by the network to establish and adopt common procedures to produce several educational paths.

The paths aim to create contexts for non-formal and informal learning, integrating and innovating the standard techniques of formal education, in order to develop a new engagement to learning and to encourage a participatory appraisal of skills.

A fundamental training goal is to develop analogic and digital skills by providing an electronic support for all the material of the educational paths [1].

The paths mainly address the secondary schools students but also to younger students, having experienced that they are mature enough, still very receptive, and willing to deal with an intense cognitive engagement. With this purpose, three themes have been chosen to articulate the main sections of the project, then conjugated in different specific sub-themes: Biodiversity and Agro-biodiversity, Color (in Nature, in Art, in Physics), Time (Geology and Fossils, Human Evolution, Time Measurement, Time in Physics, Evolution of the Antarctic).

For each of the three general themes, an introductory part linking the paths of the different museums of the Italian University Museums Network has been developed. This introduction contains a conceptual map, which has been considered to be useful in representing the general theme, the links to the specific paths, and bibliographic tools. The format of the paths is conceived to present a common structure, which is articulated in different phases and logic steps, which are illustrated by a conceptual map, a descriptive text, images and/or movies. Different in-depth materials have also been produced to make possible insights both before and after the experience at the museum and at the laboratories. In addition, each course has a specific bibliography. The documentation related to the attainment of the course with students, i.e. pictures, movies and other material, will be collected [2].

Along with these experiences aimed to orient students towards a scientific culture, the Museums of the Network decided to undertake the experimentation of 'AlternanzaScuolaLavoro' projects (work-related learning), an innovative formative stage experience in which the Ministry of the University and Research involved the students of the last three years of Secondary School, with the purpose of combining the "knowing" and the "knowing how / being able to do", opening the school didactics to the external reality.

The educational paths developed by the Museums of the Network are used to shape programs that effectively engage students in work-like experiences with a reference to Museum activities and laboratories and professional profiles. The paths tackle themes and sub-themes of the main educational project for the dissemination of scientific culture, but also more general themes linked to the knowledge and valorization of the scientific cultural heritage.

All the material produced by the Museums of the Network for both types of educational paths is published online [3], according to the above mentioned logic structure, in two sections on the web-portal of the Network (www.retemuseiuniversitari.unimore.it) run by the University of Modena and Reggio Emilia and created for the first project, approved and funded by the Ministry of the University and Research in 2012 (www.pomui.unimore.it) [4].

Fig. 2. The Network website dedicated to the project for the guidance to the scientific method and culture.

All the educational paths created by the Network of the Italian University Museums in the framework of this project are part of the permanent educational offer of the Universities through their Services of Guidance.

II. PURPOSES

At the present time science is experiencing a great paradox: it is achieving enormous advances in knowledge through multiple research activities, while its essence – the scientific approach – is spread too thinly outside the academic world.

What the education system should primarily pursue (along with to the formation of future "good citizens") is the acquisition of the ability to face reality – in its wide range of components – with that kind of approach. Today, unfortunately, because of the prevalence of a transmission-based teaching, students are induced to learn notions which often don't help them develop their knowledge and improve their comprehension, building links and relationships among things.

As Dewey wrote: "It is neither feasible or desirable that all human beings should become practitioners of a special science. But it is intensely desirable, and under certain conditions practicable, that all human beings become scientific in their attitudes"[5]

Museum is by its own nature a learning place; manners and methods of this process are varied in dependence not only on specific contexts, types of visits, occasions, but also on the relevance of practices of museum education in the learning processes.

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In the era when the criticism towards traditional didactics stimulates the identification of other solutions, if not alternatives at least complementary, museums, thanks both to their collection and to those contexts that can best benefit from modern technologies, can offer training pathways able to better stimulate and accompany the active learning processes of younger generations.

As Cavalli Sforza among others states, it is necessary to accustom the young to observe and reason, leading them to a direct encounter/confrontation with the phenomena through their hands, doing experiments [6]. Nowadays museums can play this role as a fundamental component of the whole process of acquisition of the scientific approach to the knowledge, favoring the development and the implementation of innovative processes in accordance with the principles of the informal and non-formal learning and peer-education.

The project of educational paths of the Italian University Museums Network for lifelong guidance to the scientific method and culture, based on these assumptions, aims to promote awareness about the culture and the scientific method – from conscious observation to the understanding of the phenomenon, from measurement to conceptualization – through the exploration of a series of specific themes able to encourage the direct practice of the scientific method by cross-fertilizing inductive and deductive approaches, direct experience and theoretical conceptualization, exploratory and verifiable analyses.

Thus students are led to experience the approach and the scientific method by exploring a number of fields of knowledge, in which individual Museums are able to offer appropriate experiential learning paths.

The general aim of each proposal is, therefore, common in all different cases and is pursued, with appropriate adaptations, by exploring the single subject whose specific knowledge is the second objective (the specific one). As Cavalli Sforza says, the book comes after the experience as well, we add, lecturer's lesson.

This configuration, on the one hand, puts in contact these proposals with the so-called 'flipped classroom' method, where the experience of each student precedes the teacher's intervention on the subject. On the other hand, it differs and goes beyond it, since the approach to the specific theme is characterized by an experiential nature, thus able to reproduce an engaging knowledge building rather than a self-acquisition of an already elaborated knowledge, although involving ICT and preceding class lessons, as is the case in the classical formulation of flipped classroom.

III. GENERAL THEMES

Biodiversity and Agrobiodiversity

Providing tools to know the environment around us and classifying the organisms that populate it are purposes that science museums carry on, making the results of their work available for schools and for the public, in a global situation where so many organisms are extinct and so many others are in danger of extinction.

Animal and vegetable diversity (of natural and agricultural environments) is today a topic of extreme relevance and is the foundation of natural sciences, where the experimental approach (observation, hypothesis formulation, verification and elaboration of results) is concretized.

The Museums participating to the Network's project offer educational courses, workshops and laboratories that aim to give information about the importance of biodiversity, the local agronomic varieties and their conservation, which are current themes in an ever-changing environment.

Through researches realized in the local contexts, the project aims to build a proper knowledge of local botanical varieties also to tackle the topic of agro-biodiversity, considered as a heritage to be safeguarded, promoted and valued, by maintaining alive the native varieties and their connection with the local culture and the evolution of the traditions of a place.

Colors in nature

In natural sciences, every element observed by the naturalist's eye, is also described with a color. Color has existed since life appeared on Earth and, after the appearance of green chlorophyll and red blood cells, has immediately connoted living beings in their smallest parts. Very often, besides satisfying the aesthetic taste of him who contemplates nature, color hides a functional effectiveness, which works as an important benefit to the animal or plant that expresses it. As in a continuous implementation, the colors that cover the planet are progressively changed under the guidance of natural selection. The fascinating mysteries hidden behind the various colors are unveiled by the Museums of the Network of the Italian University Museums, each one with its peculiarities and collections.

Color in art

This thematic approach to color in art is based on didactic and research experiences, already developed in various museums of the Network, with the purpose of producing a course on the colorimetry applied to cultural heritage. A laboratory with scientific instruments (eg spectrophotometer) for color measurement as well as Munsell tables, international standard to define the colors, are used. The examples in the lab will refer to objects/items of the museums such as ancient Rome marbles, historical photographs, samples of minerals but also waxes and anatomical prepapations.

Color in physics

Color-related pathways in physics aim to bring the students closer to the methodology of scientific research through the presentation of physical phenomena related to the color and the scientific procedure that led to their description, their understanding and their use.

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Time measurement

Time, and in particular its measure, has been focused by some of the Network's Museums, according to the specificity of their collections.

Several concepts of time emerged in the history of science and not only: the relational time, focusing on change and bodies' movement; the absolute time, regardless of bodies and changes; the time as an a priori subjective form, focusing on the knowing subject more than the objects to be known. Moreover, a cyclical idea of time, without origin nor end; a linear time, flowing smoothly from a source in the past to an end in the future; a reversible and irreversible time, a continuous time and a discreet time.

Evolution and natural history of man: discovering human diversity

Thanks to the paths of this section, some museums of the network intend to help students understand the work of the anthropologist through the description of methods of research and analysis allowing to discover the main differences (and similarities) between current human populations.

These methodologies can be extended back to the field of human evolution through the study of fossils, thanks to which it is possible to reconstruct the natural history of our and other species of the genus *Homo* that have populated the planet since about 2 million years ago.

Geology and fossils

The section dedicated to geology and fossils starts from the fact that Planet Earth history is over 4 and a half billion years old. In order to understand and study this long narrative, first of all, it is necessary to operate an abstraction from the short times of our human experience and to understand the role of the time factor in the mechanisms of evolution of living forms through the dynamics of great geological events. In the paths built by Network's Museums, each with special attention to its territory and its collections, the time is a key to read the main stages of the evolutionary history of life on our planet and to build a narration about how living organisms have lived in the past, their evolution and how they have been preserved to our age as fossils.

Evolution of Antarctica

For the paths of the section dedicated to the Antarctic Evolution, the Network's Museums have set themselves the goal of understanding the close link between biological evolution and geological evolution. Antarctica's example is optimal because the climatic changes recorded during the geologic evolution of the Antarctic continent, with the positioning of the South pole and the isolation from other continents, has led to an extreme simplification of life in the continent, that today is inhabited almost exclusively by microscopic life forms.

IV. EVALUATION

Special attention has been devoted to the assessment of the pathways for the guidance to the method and to the scientific culture as well as to the work-related learning, to check their strengths and weaknesses and to be able to discuss and make changes to the organization of the educational paths. With this purpose, questionnaires were produced to be delivered online to both teachers and students.

For teachers it was considered appropriate to check the effectiveness of the proposed path as far as it is understood, the relationship between the visit to the museum and the laboratory part, the materials provided during both the visit and the in-depth study to be used before and afterwards, both the efficiency of communicating the educational proposal and the function of the educational pathway in the field of didactic programming.

For students it was considered appropriate to draw up a questionnaire constituted by ten questions: five questions common to all the paths devoted to evaluating the five basic areas defined Generic Learning Outcomes, eg. knowledge and understanding, skills, attitudes and values, enjoyment and inspiration and creativity, activity and behaviour and progression.

Other five questions are dedicated to verifying the interest and understanding of the three general themes of the project (Biodiversity-Agrobiodiversity, Color, Time) while the remaining three to the different paths made by each museum.

For the work-related learning paths, it was decided to transfer the questionnaire on a computer support basis published by the Ministry of the University and Research (Education and Training System Department Directorate General for Education and Assessment of the National Education System) in the annex to the Operational Guidance on work-related learning, interesting to evaluate their organizational skills others competences they have acquired, and particularly communicative and professional.

V. CONCLUSIONS

In all the paths that the Italian University Museums Network has realized or is realizing by taking advantage of modern ICT and appropriate arrangements, the immersion in the phenomenon (more or less virtual) comes before the knowledge of its conceptualizations and this is a major stimulus to the acquisition of a specific approach and method in addition to the specific knowledge of the subject. The effectiveness of the proposal is largely dependent on the proactive integration between schools and Museums, that today is, unfortunately, the major constraint to the development of innovative learning methods, of which the Network's Project is one of the possible expressions.

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Academic heritage as a tool for the development of future scientific careers

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***Abstract*— The project for Innovation and Improvement of Teaching Quality "Academic Heritage as a tool for the development of future scientific careers" pretends to use existing important historical academic collections to strengthen ties between university and school contexts. The research has focused on the study of anatomical models of comparative anatomy kept at two of the most significant educational institutions of different academical levels: the San Isidro Secondary Education Institute and the Veterinary Faculty of the Complutense University of Madrid, both located in the city of Madrid, Spain.**

To compare both educational contexts we focused on their museums that contain significant collections. Among the objects in custody we have chosen the zoological models and, in particular, a piece that we can find in both museums: the clastic model of the viper head made by Dr. Auzoux. This will be the starting point for future actions.

For the development of the project a multidisciplinary team has been assembled consisting of lecturers, students (both from university and Institute), researchers and technicians. The fundamental lines of our research have focused on the didactic use of these pieces, including the documentary study and the conservation and restoration of the viper head using proper techniques.

Dissemination activities of this heritage comprised three directions, taking into account our main objective: to recover the interest of classical models as didactic materials. 1. Exhibition for general public; 2. Elaboration of didactic booklets directed to the school public and 3. The design of 3D recreations for the web.

***Key words**: academic heritage, anatomical models, Auzoux*

I. INTRODUCTION

Between 1836 and 1845 the majority of the Spanish secondary education schools were created. In the science area the subject of natural science was included. The teaching aim was to strength the observation capacities of the students stimulating the material progress and facilitating the development of future professional scientific careers. The trend was to intensify the teaching of sciences creating pedagogical laboratories seeking human progress, cultural actions and the development of individuals [1]. University and secondary education centres must count with adequate scientific material. The Educational law of 1857 in its article 14 established "as effective means to expand and complete the progress of Science, the Administration will seek the growth of academies, libraries, archives and museums, and will create new schools for the higher level of science [2]. How this was accomplished along more than 150 years is an interesting lesson to be learnt.

II. CURRENT STATE OF THE ART

Today we face an unexpected panorama, the scientific collections have suffered multiple mishaps, and most of the collections are dispersed, were lost or were moved to the national museums or universities. The concern was so great that the National Association for the Defence of the Heritage of Historic Secondary Schools was created in Spain in 2010.

Despite the difficulties encountered, there are notable exceptions and significant collections that have become museums that is the case of the museums located in historical Secondary Schools such as Padre Suárez in Granada created in 1997, San Isidro, opened in 2014 or the Scientific Cabinet of the Cardenal Cisneros both located in Madrid. The latter have been part of the CEIMES [3] project funded by the Ministry of Innovation and the Community of Madrid. Its aim was to safeguard and enhance their scientific and educational heritage using new information and communication technology to advance in the knowledge of educational innovations when experimental science was a must for teaching.

On the other hand universities have created their museums with scientific historical material from multiple sources being the Complutense University of Madrid the one that most museums and collections own among them the Veterinary Museum. The similarity of the collections and the purpose for which they were formed facilitated the search for the

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connections between educational settings that allow the continuity of scientific careers.

III. THE TEACHING OF COMPARATIVE ANATOMY

Anatomical models were created for educational or research purposes, since the 18th century and have been manufactured in different materials: wax, papier-mâché, plaster and plastic. In its origins anatomists and artists worked together to produce pieces endowed with great realism and quality, although they could not replace the originals. These 3D models showed more detail and were more didactic than any illustration, so they became the best teaching instruments.

In the second half of the nineteenth century anatomical models were widely accepted, the target groups were mainly schools, universities, hospitals and public institutions. Dr. Auzoux was the most famous and successful builder, his papier maché models won the approval of scientific and medical academies and soon became a commercial success. They were sold all over the world until the models made in plastic or plaster replaced them.

IV. THE DOCTOR AUZOUX AND THE MANUFACTURE OF ANATOMICAL MODELS

Louis Thomas Jérôme Auzoux (1797-1880), physician by profession, was a fundamental person in the teaching and the dissemination of anatomical knowledge thanks to the creation of his models in three dimensions. These so-called models of clastic anatomy were designed to be disassembled in order to facilitate learning for students in schools and universities.

For the manufacture of solid parts were used metal moulds fixed on a wooden support. The raw material was a mixture whose main component was the pulp with which the moulds were filled and pressed. Later the models were painted to accentuate their reality and finished with a layer of protection. Hinges and bolts of iron or copper were used to hold the pieces [4].

These models were marketed throughout Europe, Egypt, the East Indies and South and North America, especially the United States. Today, many of these models are preserved in schools and universities around the world and are considered a valuable historical and scientific heritage that must be preserved and disseminated.

V. THE ANATOMICAL CLASTIC ZOOLOGICAL MODELS OF HIGH SCHOOL SAN ISIDRO

From the second half of the nineteenth century on the secondary schools were created natural history chairs. The first professor of natural history of the high school San Isidro D. Manuel María de Galdo López de Neira believed that in the study of the subject it was necessary to give more extension to the experimental and practical part than the theoretical one. For this it was necessary to obtain the necessary materials.

In 1869 the first clastic models of Dr. Auzoux was acquired. In 1877 several models were bought in Paris and others were obtained from Spanish distributors. During the nineteenth century a total of 68 models were assembled, of which there are currently 39 (26 are of comparative anatomy: 7 human models and 19 zoology) [5]. Most of the Auzoux models were manufactured prior to 1880 and are signed with the following formula "Auzoux doct. Fecit anno... "

VI. ANATOMICAL ZOOLOGICAL MODELS OF THE VETERINARY SCHOOL OF THE COMPLUTENSE UNIVERSITY OF MADRID

The enormous expansion of the classic models of Dr. Auzoux since the mid-nineteenth century, reached the Veterinary Schools especially in Europe. The Complutense University of Madrid, and in particular the Complutense Veterinary Museum as depositary of the funds of the first School, has a unique and representative set of models of zoology and domestic animals. It is noteworthy the premature interest in comparative biology shown by these funds, as we find delicate models of the nervous, digestive and cardiocirculatory systems of insects, reptiles, birds and marine specimens [6].

They have a special visibility the viper head with a striking aesthetic value and, the model of turkey clastic, which with its 16 pieces constitutes a precise anatomical puzzle. Also it emphasizes a set of pieces purely veterinary relative to the cow and the horse.

VII. THE VIPER HEAD BY DR. AUZOUX

This piece has been the object that has articulated the project. Looking back to the importance of the 3D models we try to update their use with the new technologies. To raise awareness through its knowledge, the first step was to find documentation, task carried out by high school and university students. The second was to achieve its legibility and ensure its survival through its restoration consisted fundamentally in cleaning and consolidation (Fig 1).

Fig. 1. Restoration in process.

The dissemination was made through the exhibition organized at the high school grounds to celebrate the International Museum Day (Fig 2). Finally, we worked in the creation of

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didactic materials, an example is the booklet called “Auzoux the snake charmer” aimed to school students which seeks to discover Dr. Auzoux and the Viper. Also the design of 3D recreations expects to make accessible the anatomical model on the web to everyone.

Fig. 2. Exhibition in the I.E.S SAN ISIDRO School.

VIII. APPLIED TECHNOLOGY: PHOTOGRAMMETRY

In order to participate in the importance of Academic Heritage inherited from Dr. Auzoux, our research project intends to continue with its pedagogical line, looking for new languages that are better adapted to current students.
With this objective, we are making digital photogrametries that will allow us to appreciate the piece both bi-dimensional and three-dimensional, both in its general views and each of the elements that make it up.

For image capture to perform photogrammetry, the same guidelines and recommendations [5] will be followed which have been put into practice to document the piece.

Used Tools are in Hardware, Reflex Camera, ColorChecker Passapart. Software used, Photoshop, PhotoScan Pro 1.2.3 and platform Sketchfab to disseminate digital image.

The process begins with the capture of several images, rotating the object and in different levels. In relation to photogrammetry, once edited the image will be archived with the extension.psx, and to be shared and downloadable we export it as Wavefront OBJ (.obj),.mtl,.png, and three files will be used to export it to the platform Sketchfab. In this platform it will be possible to see the results in 3D.

Sketchfab is a web page specialized of sharing 3D content. It will be freely accessible and you will have the option to download the file. It should be noted that this page has a special category that is Cultural Heritage & History where all the 3D graphics that are related to this topic will be available.

The access to our project is: https://skfb.ly/68Vvq

Quality control has been followed according to ISO 15489-1:2016: Information and documentation. Records management. Part 1: Concepts and Principles.

IX. RESULTS

This initiative seeks to arouse interest in the academic heritage and help in its conservation. The valuable didactic materials used in the past for the teaching of the sciences claim their pedagogical and patrimonial function inside and outside the educational context.

The students' interest in the study of comparative anatomy has been verified, starting with pieces of Cultural Heritage and generated with 3D tools, providing:

1. Access to scientific knowledge from the current language such as digital.
2. The possibility offered by digital tools to spread it on the Internet.
3. The revaluation of Cultural Heritage in the academic environment of secondary and university education.

Fig. 3. Teaching students with anatomical model.

Fig. 4. Performing with students the photogrammetry.

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Digitization of museum specimens and development of novel tools in biology courses

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***Abstract*— The Biology Department of the University of Lille (France) possesses an ancient naturalist collection of more than 3000 specimens covering different fields in biology (botany, embryology, zoology), including several rare and historically precious samples of the end of the 19th century. Several hundreds of specimens from this collection are regularly used in practical courses. It implies their manipulation by students with a high risk of damage for this irreplaceable material.**

We recently developed two projects aimed to preserve the collections, make them worldwide visible and improve their didactical use. The first one concerns fragile and ancient specimens (i.e. embryology models in wax) that are scanned and will be replicated by 3D printers for a free manipulation in practical works. The second project is the digitization of samples by a high-definition photo 3D system so far never used for this kind of purposes. Specimen pictures can be virtually manipulated by students on any support (computers, tablets, smartphones) preserving them from the risk of damage. In addition, images can be integrated in different multimedia e-Learning tools and made available on the web for a large utilization in education (http://photo3d.univ-lille1.fr).

IndexTerms *Naturalist collections, photo 3D, zoology, e-Learning*

I. INTRODUCTION

Ancient naturalist collections have an important value in term of historical heritage and scientific interest as well as a large potential for education. The Biology department of the University of Lille has a large collection of specimens that date back at the end of the 19th century. These samples are currently used for practical work with bachelor students, which implies a high risk of damage. We recently developed two projects aimed to digitize these collections to preserve them by further handling and to offer at the same time new online tools for teaching life sciences in any school level.

II. THE NATURALIST COLLECTIONS

Originally stored in the ancient building of the Faculty of Sciences in Lille (1874), the collections of the University were moved to the novel campus at the end of 1960s. Many samples remained in the original building (presently the Natural History Museum of Lille) but during the transfer, most of data concerning the origin of specimens were lost. This is why we are currently inventorying specimens and investigating their origin to appreciate their historical value. The present collection consists on several thousands of samples covering different field of life sciences (zoology, botany, embryology, paleontology,…). The zoology collection, in particular, includes hundreds of Vertebrates and Invertebrates specimens (skeletons, jars, stuffed specimens, wax models, entomology boxes,…). We recently started a large operation to valorize this heritage and improve its use in education for biology students. We started with the restoration of these samples according to different repairing and cleaning techniques [1] [2] [3]. Once the specimen restored we moved to the digitizing procedure and to the accomplishment of two projects aimed to improve the link between museum specimens and didactical utilization.

III. THE DIDACTICAL USAGE

Around 300 samples of naturalist collections of the biology department are regularly used for practical work with students. The aim is to show the stuffed specimens and/or wax, papier-maché, or plaster models to illustrate the morphology, the anatomy and the features of the different animal or vegetal species. It implies their handling by hundreds of students every year, with a high risk of damage and wear for the samples. To avoid these problems and preserve them from this kind of dangers, we recently started the digitization of collection specimens by a HD photo system. The free access to these pictures permits the students to observe the samples into the smallest details on any connected device. In this way they can 1) prepare the practical sessions at home, 2) use the 3D photos during the practical work without touching the material and 3) revise their lessons before the exams.

IV THE 3D PRINTING PROJECT

As indicated before, some of our collection specimens are not only historically important but also fragile and irreplaceable.

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Wax embryology models made by Adolf Ziegler (1820-1889) and his son Friedrich Ziegler (1860-1936) (Fig. 1) belong to this kind of samples and their handling is now forbidden for students. These specimens have been digitized and are currently treated with the AgisoftPhotoScan software to perform photo-grammetric processing of digital images. It will permit to reproduce the specimens by 3D printers. Students will be able to touch and work with the replicas during the practical sessions and observe all the details of the original specimens using the 3D pictures performed as described below. In this way the original samples are definitively stored and protected by any handling danger. This project can be extended to any other museum specimen and the 3D replicas of specific objects can be used for a large panel of didactical purposes in other school levels [4].

Fig. 1. Wax model of amphibian development (Ziegler).

V. THE PHOTO 3D SYSTEM

Our establishment recently acquired a Packshot Creator system to get 3D images of objects. To our knowledge it is so far the only system used in a public structure in Europe for scientific, historical and didactical purposes. The apparatus consists of a mechanical arm holding five digital cameras (angle choice 0°-90°) coupled to a programmable rotating plan supporting the specimens (angle choice 1°-360°) (Fig. 2). Picture capture takes a few minutes and is operated by a software synchronizing the activation of digital devices and the rotating plan. The software integrates all the pictures to produce HD (16 MP) images of the specimens. Interestingly, user can get 360° as well as hemispherical or spherical views of the objet. Image files can be exported under a large choice of formats (jpg, tiff, raw, png…) and observed on different kind of devices (smartphones, tablets, computers). Images are stored at local server at the University of Lille. Animated 3D images in HTML5 are hosted by the open source database Piwigo.org© in the interoperable SQL format. A virtual "Natural History Collection" containing several hundreds of pictures issued from our specimens is already available on the web (http://photo3d.univ-lille1.fr).

Fig. 2. Photo 3D set up showing the image capture of a hippopotamus skull issued from the zoology collection.

VI. THE "SPECIMEN AT THE GLANCE" PROJECT

To improve the utilization of the 3D pictures, we consider the integration of 3D animated images described above into "enriched" files containing legends, texts, links and others interactive resources. It will be performed using a responsive web design software (Adobe Muse) permitting the utilization of the multimedia content on any support (smartphones, tablets…). The aim is to give the students the free access online to practical files "at the glance", e-books or novel e-Learning tools illustrating different topics. The project presently developed concerns the production of animal biology files explaining the relations between mammal diet and teeth/skull structures and evolution (Fig. 3). Interestingly, this kind of tools can be easily adapted for different school levels coming from primary to university classes, just modifying the content and the vocabulary of the document. In addition, these documents, presently written in French for a local utilization, can be replied in English or in other languages for a worldwide diffusion.

VII. FUTURE WORK

In the next years the project could evolve towards an augmented reality (AR) program. Once treated by software generating 3D spatial data, images would be used in an AR interactive environment where students could observe the internal anatomy [5] or other details of the specimens. In addition, the same approach could be adapted for primary or secondary schools to display the animals in their habitat. In that case the virtual environment would reproduce a natural background obtaining a diorama-like effect enhanced with AR potential.

VIII. CONCLUSION

The innovative photo3D system and the applied projects presently lead by a group of teachers at the Biology Department of the University of Lille Science and Technology will permit the development of novel applications to improve the use of naturalist collections for bachelor or master degree

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students but also for any other school level. These technologies can be easily extended to other scientific domains (physics, chemistry, earth sciences,..) as well as to art, manufactory, archaeology or any other field to bring closer museum collections and education. The simple adaptability of these resources to any multimedia device might open new pathways for the transmission of cultural heritage to next generations.

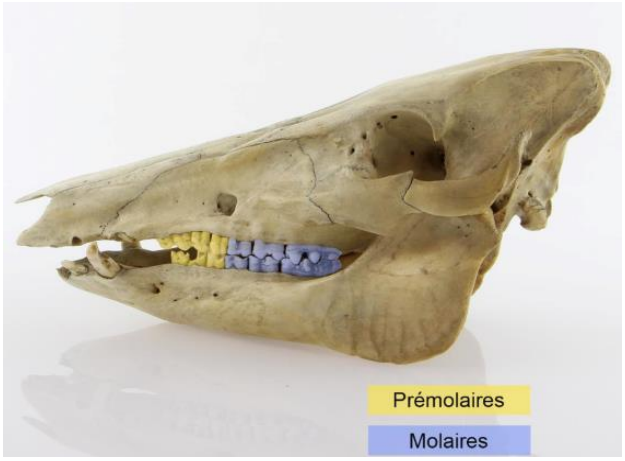

Fig. 3. Image capture issued from the photo 3D of a wild boar skull with an example of graphic enrichment to show specific teeth placement.

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The cultural heritage to improve skills and to create a bridge between school and museum

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***Abstract*— Cultural heritage education can provide information in different fields due to different ways one can use to approach them, depending on the context: given its nature, it can in fact represent both object of study, meaning and aim. This means that cultural heritage allows for a multidisciplinary approach, being related to several aspects of human life. This is a fundamental feature when it is employed in the school environment.**

Starting from these assumptions, we present the project Observing artwork as a form of education for learning and citizenship, started in the school year 2015/2016. This project has proposed a practice allowing for the use of cultural heritage within classrooms as a multidisciplinary learning tool, by means of the Visual Thinking Strategies (VTS) method.

VTS focus on the learner, placing him at the centre of the learning process. The student, by means of his knowledge and experiences, constructs the meaning of image represented by an artwork, cooperating with his classmates, aiming at learning to learn. Hence, it is a method that addresses the needs of the application of the constructivist theory in the scholastic environment.

In order to bring cultural heritage inside classrooms, educational activities are carried out using digital resources, such as visual artworks repositories, and technological devices, like interactive whiteboards displaying pictures employed for the VTS practice. For this purpose it has been in our interest to keep teachers upgraded regarding digital resources possibility access.

Index Terms *cultural heritage in education, flipped museum and learning*

I. INTRODUCTION

Cultural heritage, as a sign of human actions carrying the value of civilization, allows us to acquire a plurality of information, notions and stories regarding any aspect of human life. This implies that cultural heritage's education can provide insights into different contexts. Moreover, given its nature, it can be studied not only by itself, but also in a bigger framework in which it can represent the mean to approach different areas of knowledge; furthermore, it can be the aim of a study, since it requires awareness about its safeguard, conservation and protection issues [1]. Cultural heritage, therefore, is well suited to school learning since it can be used for multidisciplinary learning.

CULTURAL HERITAGE EDUCATION AND CONSTRUCTIVIST LEARNING THEORY

Introducing cultural heritage education in school curricula is therefore deeply appropriate: this is due to the fact that messages carried by cultural heritage can be understood with different manners of interpretation. According to constructivist learning theory, these manners belong to us, since we can look for them in our experience, knowledge and observation capacity [2]. However, it is fundamental that the study of cultural heritage is carried out methodically: in order to be effective, learning has to fulfil needs and preferences of the student.

Indeed, learning has to be an active process in which students construct their own knowledge by themselves, during a social activity which involves interactions with others. In the learning process, what students know and have experienced so far are the foundations for building future knowledge.

II. VISUAL THINKING STRATEGIES

It is possible to approach cultural heritage education consistently with the prescriptions coming from the constructivist theory by means of the Visual Thinking Strategies (VTS) method. Developed in the eighties by Abigail Housen, a cognitive psychologist, and Philip Yanewine, an expert coordinator of educational activities at MOMA, the VTS method is based on conducting a discussion with a group led by a facilitator, answering three questions about an artwork: What's going on in this picture? What can you see that makes you say that? What more can you find [3]?

Placing every student at the centre of the learning process, the VTS method makes the learner able to construct the meaning of the image represented by an artwork and, therefore, to build his own knowledge. The previous knowledge and experiences, the interaction with more capable peers, the activation of observing and reasoning are all fundamental elements for the application of the VTS method.

The purpose of the application of the Visual Thinking Strategies is not only to get new informations about a certain artwork, but, most importantly, to learn a method which enable students to solve problems: VTS method teaches students how to learn [4]. Furthermore, using VTS allows to discover and understand and, therefore, to respect and protect cultural heritage.

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III. VTS AND SCHOOL. THE ITALIAN EXPERIENCE

Starting from 2015/2016 school year, the project Observing artwork as a form of education for learning and citizenship proposed for the first time in Italy the introduction of the Visual Thinking Strategies in school curricula. Within a year 2600 students of all ages, together with their teachers, took part in laboratory practices, consisting in the application of the VTS method, both in classroom and in museum contexts, with the support of a tutor. The activities carried out included also the introduction to the teachers of the VTS method and of the digital resources possibility access. A total of 10 schools have been involved in this project [5].

The Visual Thinking Strategies method can be applied in both formal contexts, such as school and universities, and non-formal learning ones, such as museums.

Using VTS in museums allows us to apply the method to any kind of artwork and media: not only paintings or graphic works, but also sculptures and bas-reliefs, models, diorama and any object that is part of our cultural heritage can be involved in the practice.

Applying the VTS method in school context, on the other hand, implies new needs, but also opens to endless possibilities. Usually pictures employed for the VTS practice are displayed on the interactive whiteboards; therefore, it is recommended to choose only two-dimensional artworks, according to the needs to reproduce faithfully the original picture. Using technological devices to bring cultural heritage within classrooms also means to fully exploit the opportunities that the digital resources access offers.

Cultural heritage education employed in the classrooms becomes part of the student's everyday life; thus, this involves the development of interest, familiarity and affection for cultural heritage.

When Visual Thinking Strategies are applied in museums, it is important to ensure that both teachers and museum staff are aware of the needs associated with the use of exhibition spaces as a place of learning and the need to make students protagonists of their own learning.

Regarding the choice of the artworks to analyze in classrooms, the teachers are suggested to pick pictures later available to the students during the museum visit: this will make the museum a closer, more understandable and engaging place, resulting in an enjoyable visit.

IV. RESULTS

To assess the impact of VTS practice in the school context, teachers were asked to fill in a form to record their first evaluation about the student's reactions to the method. These forms show that the VTS method can be considered effective for acquiring and developing soft skills: students are capable to obtain new abilities and capabilities thanks to a collaborative work environment. As a consequence, social inclusion has been encouraged, since VTS favor the active participation of anyone who has a disadvantage.

Presently, we are studying a way to perform quantitative analysis capable of gauging the improvement of learning capabilities in students practicing the VTS method.

V. CONCLUSIONS AND PERSPECTIVES

Given the positive outcome of the experience, we can state that VTS method can be considered a valid learning tool. Therefore, our perspective is to proceed with the experimentation not only in the school context, but also in medical and health education and in the long-life learning context.

Moreover, the collaboration between school and museum was found to be crucial in developing a bridge between the two learning environments: a new type of dialogue is being opened up to experimenting new approaches to museum visit.

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Why can Flipped Learning experience be so meaningful, in relationship with cultural and museum heritage?

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***Abstract*— And now the question is: Why can Flipped Learning experience be so meaningful, in relationship with cultural and museum heritage? Maybe because it can play a central role in engaging future citizens in the development and enjoyment of cultural heritage. Flipped Learning can raise students' awareness of the historical legacy of their own territory by increasing interaction with the network and the use of technologies. The Life Long Learning model fits with Flipped Classroom: students are involved in museum or art related experiences before going there and then directly and consciously using art. They can challenge themselves in a video game set in the places to visit or work with an artist and then exhibit their work next to those already in the galleries. Storytelling of works of a museum collection or shared creativity can be the frontiers of the Flipped Museum. Those frontiers are now wide open**

Index Terms *flipped museum, online work, technologies, engage, identity, storytelling*

I.

An educational method we call *Flipped museum* involves providing the opportunity for children and young people, using online films prior to their physical visit to the museum, to access information that was previously conveyed via guided tours. This means that their visit to the museum can involve more creative, innovative and discursive elements. An example about that is The Royal Coin Cabinet. This museum is a museum that specialises in economic history and the history of money. Situated in Stockholm, it is the only museum of its kind in Sweden. Through Flipped museum they want to reach more schools that are not situated in our immediate vicinity. They want to encourage visits to the museum, but it is also possible to make use of the films and exercises on the website without actually visiting the museum.

A parallel to the concept of flipped museum exists within the educational system and is called *flipped classroom*. This involves the teacher providing pupils with access to presentations and instructions as homework using a website. As the pupils gain access to the teaching content in advance, they can prepare in peace and quiet and come to school curious with their ideas already developed. More questions will have time to mature and more of the lesson can be devoted to discussion and progression, rather than simply going through the material. The "flipped learning" movement is spreading—and not just in classrooms.

II.

Another one: The North Carolina Museum of Art has developed a pilot program modeled after a flipped classroom, in which the traditional instructional approach is reversed. In flipped classrooms, students prepare for class instruction at home with extensive online work, often through reading or videos, so that they can engage in more analytical, in-depth, project-based work during class time. The North Carolina museum is trying to order students' experiences in a similar way.

The result is "Artists in Process," an effort to create a "flipped museum" that will engage students more effectively than a typical field trip would. Just like a classroom is not a one-size-fits-all experience, the museum should not be a one-size-fits-all experience. They wanted to give a lot more choice to the students to deepen the connection that they have to art, [and] personalize the learning for themselves.

The North Carolina museum's “flipped” model works this way: students study and investigate art in their schools – sharing ideas online with students from other parts of the state – before coming together to stage a virtual exhibition at the museum. When they return to their classes, they create their own individual art projects, informed by the works they have seen.

The museum provided students with access to videos, articles, and artist interviews as background material, and gave them the freedom to pursue individual areas of interest. They chose from three concepts: identity, storytelling or place, then identified artists they wanted to examine more closely, and conceived initial ideas for the art they would create after visiting the museum. During this time, the students shared their ideas and progress with each other through a Web platform NCMA created with a North Carolina-based technology company, Odigia.

This online space was designed to facilitate their conversation in a collaborative community environment. When the students visit the museum, they meet their peers from their partner class and work in small groups to curate a

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virtual exhibition on a chosen social media platform. The prior preparation and "flipped" model allow the students to make relevant connections, discover new artwork, and feel confident exploring the gallery. Students are preloaded before they come to the museum, with some experience, some familiarity, and build upon that through active learning approaches once they're there.

III.

Even in Italy we have our example of flipped museum. "Father and Son" is the first videogame in the world produced by an archaeological museum, the Mann of Naples, which houses the extraordinary collections from Pompeii and Herculaneum, the Farnese and Egyptian collections. "Father and Son" is a 2D side scrolling narrative game, in English and Italian.

It's free and without advertising. The National Archaeological Museum of Naples, which will also propose a line of games related to video games, plays a crucial role in the development of the game. Among the features there is the "check-in" functionality that allows you to sew a relationship between the digital content of the video game and the physical space of the museum.

The system recognizes the presence of players within 20 feet of the Mann and will unlock new character dresses and a new playing location. For the preview presentation of the game, the opening day of the Mann Festival - Museum at the Museum was chosen.

In "Father and Son" the player is Michael, a young man who goes to Naples after receiving a letter from his father, who had been an archaeologist. The directions contained in the letter will take you to the National Archaeological Museum of Naples. The adventure start at home and continues to the museum.

IV.

And now the question is: Why can Flipped Learning experience be so meaningful, in relationship with cultural and museum heritage? Maybe because it can play a central role in engaging future citizens in the development and enjoyment of cultural heritage. Flipped Learning can raise students' awareness of the historical legacy of their own territory by increasing interaction with the network and the use of technologies. The Life Long Learning model fits with Flipped Classroom: students are involved in museum or art related experiences before going there and then directly and consciously using art. They can challenge themselves in a video game set in the places to visit or work with an artist and then exhibit their work next to those already in the galleries. Storytelling of works of a museum collection or shared creativity can be the frontiers of the Flipped Museum. Those frontiers are now wide open.

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Western influences in Medieval Macedonian art, museum and educational context

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***Abstract*— Westernization to a certain degree with specific local characteristics is one of the specifics that appeared in the late 13 and early 14th century in medieval Macedonian art. It was related to the Italian region and some of the cities at the Adriatic coast of Monte Negro and Croatia. The sculptural Romanesque elements in several churches in Macedonia are so far dated to the 14th century and show Dalmatian (Dubrovnik) and Italian influences. This paper will deal with the relations and ways of receiving influences and vice versa.**

Index Terms *medieval art, romanesque style, fresco painting, education*

I. INTRODUCTION

Partial Westernization is one of the specifics that appeared in the 13th century and the early 14th century in medieval Macedonian art, probably due to the fall of Byzantium from 1204-1264. The western culture influences were not strange for the Eastern Roman Empire, it was very "in" during the reign of Manuel Komnenos. It is the time when heraldry became the immanent language and source of the western noblemen and Crusaders spread it in the occupied Byzantine territories. Manuel Komnenos accepted the western heraldic emblems and this we see at the Macedonian St. Panteleimon church at Nerezi, Skopje, applied on the shields of the holy warriors who at the same time are portraits of the members of the ruling dynasty [17]. This monument erected in the time of Manuel shows Byzantium was going to use the heraldry language originated in the West. Only the change of dynasties seems to stop this process.

Not only Byzantium has received western art impulses during the fall from 1204-1264. Italy even a century later than the Balkans continued to be beautified by Komnenian style frescoes.

There are a lot of examples of direct Romanesque artistic architectural influences in medieval Serbia, yet they are not present in Macedonia, thus showing different taste and probably official ecclesiastical attitude. What we see as partial usage of Romanesque art (already substituted by Gothic style in the west for more than a century), are archaic sculptural Romanesque iconostases and façade rosette (St. Athanasius, Lešok near Tetovo), capitals and façade rosette (Holy Virgin Matejče, Kumanovo) capitals within the pseudo iconostases (St. George, Staro Nagoričino, near Kumanovo; St. Demetrius, Marco Monastery near Skopje etc.) but no outer Romanesque decoration nor traces of changes in plan or building of separate bell tower as it happened in Serbia under Italian influence. It is possible the church of Holy Virgin in Drenovo, near Prilep, possessed a separate tower like those in Italy since the early Christian period, yet it is not preserved and there is a new one from the 19/20th century in front of the church, on the southern side.

In the 13th century at Virgin Ljeviška there is a fresco of Virgin with Christ who feeds (nutritive) that can be related to some not attributed yet Florentine contemporary paintings of Virgin with child, as Svetozar Radojčić has noticed over 60 years ago (ref.1, 27). He has also indicated the similarities between the scene with the Christ's Deposition from the cross from Mileševa church (1222-1228) and the same scene painted by Siena painter Guido de Siena fresco from the eight decade of the 13th C. (today in the National Pinacoteca in Siena), (ref.2, 26). Valentino Pace thinks of artists coming from Macedonia or Serbia in general in the late 13th C. spreading compositional models, repertoire, physiognomies and technical solutions inherent to the art of the byzantine commonwealth. Patmos, Cyprus, along with Sicily, for Pace are the places to spread this artistic influences. Rosa d'Amico also stresses the Byzantine Italian connection through the Balkans. She mentions six art centers in Italy with Byzantine art influences, partly received through Serbia: Venice, Rome, Ferrara, Rimini, Bologna and Siena. Siena frescoes are painted by Duccio, one of the supposed inspiration for an icon from Virgin Perivleptos in Ohrid, from the 14th C.

Rosa d'Amico and Pajić think the above mentioned Mileševa fresco and the Toscana paintings Radojčić analyzed have been actually inspired by models created in Pisa, more precisely by the colonies at the Eastern Mediterranean region Pisa founded some time earlier [3]

As for the Macedonian Romanesque sculpture and icon of the Virgin with child from Ohrid (inv. no 81) there are opinions they were made by artists (workshops) coming from the Adriatic coast centres [7], [9].

II. SYMBIOSIS BETWEEN THE EASTER AND WESTERN ICON PAINTING

Painting on wooden panels had not been common in the West, but by the 13th C. till 1300 the gilded and painted panels of elaborate altarpieces had begun to join – and would eventually overshadow – fresco and mosaic in Italian churches. Western

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artists working on panel turned for inspiration to the Christian East, adapting the techniques, style, and subject matter of Byzantine icons. It was in the 14th C. when the authentic western icon came to life, free from direct byzantine influence. It was the time when some western painters began to paint with tempera colors over punched golden grunted panel (Duccio, Giotto, Fra' Angelico). Cretan School describes an important school of icon painting, also known as Post-Byzantine art, which flourished while Crete was under Venetian rule during the late Middle Ages, reaching its climax after 1450, becoming the central force in Greek painting during the 15th, 16th and 17th centuries. The Cretan artists developed a particular style of painting under the influence of both Eastern and Western artistic traditions and movements; symbiosis between the eastern and western icon painting. Also the Sicilian workshops show mixed styles, and so do the workshops at the Adriatic coast in the late 13th and 14th centuries.

III. MACEDONIAN MIXED STYLE ICONS

There is a very small group of icons in the Ohrid collection of icons in Macedonia that makes direct association of Western art, represented with the icon of the Virgin with Christ (inv. no. 81), the processional icon of the Holy Virgin Psychosostria (inv. no 82, fig. 7), both from the Holy Virgin Peribleptos church, and the icon of St Nicholas, from St Nicholas Gerakomia in Ohrid church (repainted in the 19th C.), [16]. Neither of the icons has been X-rayed so we do not know how many layers there are due to the 20th century conservations. The icon no. 81 shows combination of byzantine and probably Italian late Gothic and Renaissance features. The close relationship between icons and frescoes is evident in the art of Ohrid starting from the 11th C. Fresco-painters worked as icon-painters during the entire medieval period. The icon was often the means of launching new ideas in art [5]. According to some sources (Zakonski spomenici), Tsar Dušan has confirmed the earlier gifted villages and privileges to the Perivleptos church, due to the help of the Virgin to cure him (1340?). Vasić thought King Dušan issued a charter to the church and the icon with inv. no 81 adjoined it [6].

Influences

Where did the influence of the Western come from? In Serbia in the 2/4 of the 14th C. appeared the so called "pictores graeci" (Greek painters) who were mostly Byzantine artists engaged along the Adriatic coast. Viktor Lasareff thinks that from 1160-1190 Byzantine art underwent such radical changes at the hands of Sicilian artists that we may confidently characterize these Sicilian modifications as the first step in the evolution of the so-called "maniera bizantina" [7]. Their stylistic concepts may have reached Macedonia after its fall under the rule of the Serbian medieval state in the late 13th century. Patmos, Cyprus, along with Sicily, for Pace are the places to spread this artistic influences [3]. Lasareff had discussed the relation between the Italian *maniera greca* and the Cretan school of painting, and attributed the Cretan icons painted *a la latina* to an Italo-Greek school active in Venice in the 14th century [11], [12], [13]. Ana stasia Drandaki disagrees with the existence of such school in Venice; she claims it is Cretan school. She says the question remains: does the application of the term "Greek manner" for the 13th C. and the 15th and 16th centuries describes two distinct artistic phenomena going under the same name, or, related, consecutive manifestations of the same phenomenon, which then obliges us to examine the term in a wider time frame and geographical context? She mentions commissions for works in a mixed Italo-Byzantine style, which were intended for public worship, from patrons with financial potential and high artistic expectations to answer their devotional needs and serve their political and ideological agendas.

It is precisely the needs and purposes of those clients that make the eclectic artistic physiognomy of such paintings meaningful. "Describing a work as a product of the "Greek style" does not assume that it came from Byzantium or that the artist who created it was Greek. It only assumes that the artist adopted those iconographical or stylistic features which sufficed to ascribe the work to that tradition in the eyes of the viewer [14].

Fig. 1. & 2, St. Panteleimon, Nerezi, 1164, Skopje, R. of Macedonia.

Fig. 3 &4 Siena, crypt of the cathedral, 13th C.

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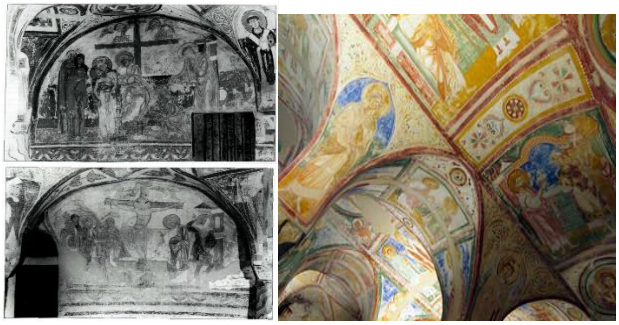

Figure 5 &6, Aquilea, crypt of the basilica.

IV. MACEDONIAN ITALIAN CONNECTION

Nerezi church of St. Panteleimon shows the best example of emotional Komnenoi art (fig. 1, fig. 2), not to be seen elsewhere. Its influence over Italian art of the late 13th c. in Aquileia, Siena and Parma (figs. 3-6) are examples of longer endurance of specific byzantine art from Macedonia (Nerezi and Kostur, Holy Anargiri) in the west that was appreciated and valued over the contemporary Gothic style. Valentino Pace thinks of artists coming from Macedonia or Serbia in general in the late 13th C. spreading compositional models, repertoire, physiognomies and technical solutions inherent to the art of the byzantine commonwealth. Rosa d'Amico also stresses the Byzantine Italian connection through the Balkans [3].

There are representative examples of the Romanesque influence in the decorative sculpture of Macedonia [15], dated to the 14th C. Some scholars relate the artistic influences expressed with the Dalmatian ateliers of the contemporary period. Among the centers Kotor seems to be very active. It is the city where from came the painters of Dečani (fig. 9), and the painter of the icon of St. Nicholas in Bari. Yet in my opinion it may also be a local Balkan school situated in today's Greece continental region or Greek islands.

In the 16th, 17th, and 18th centuries there is Paleologian inspiration in the art (better to say the classicism expressed in it) that was combined with slight details borrowed from western baroque art, mostly columns with capitals, porches, reflected in the art of the painter David from Selenica. The manuscripts of the 16th C., including the recently found Benče manuscript (Makedonska Kamenica), are also associated with the classicism of the Paleologue period. Yet, we also see in other icon painters work of the 16th C. late medieval western type of fortifications and towns (painter Jovan Teodorov from Gramosta and Jovan (John) who worked in the Slepče Monastery church). The miners town of Kratovo had even one third of the city inhabited with western citizens (miners), or catolics, named Latini's quarter. Its bridges and towers show combination of western and eastern models adopted to the place and make the city panorama the most impressive and unique.

The so called Skopje 2014 projects brought usage of decorative elements of classicism, again columns and capitals, and as new element the tympanum as main decorative tool on the facades. It was wrongly read as baroque by the first journalists presenting the project in the media, due to their lack of art history knowledge. This adjective baroque is still used when referring to the project, in pejorative meaning. The classicism was to a small scale used in the buildings of the early 20th centuries, mostly destroyed by the Skopje earthquake in 1963. There are still some small houses that survived to prove this, along with other buildings in other cities like Bitola, Resen. These original buildings that come from the early 20th century were not the main stream but one of the adaptation of popular in SHS Kingdom western styles used by the rich population. The other citizens were practicing national architecture, still on display in the numerous villages, to mention only Kruševo, Galičnik, Ohrid, Bitola, Berovo, Kratovo, and Resen.

V. CONCLUSION

Macedonian medieval cultural heritage shows there is no simple distinction to Byzantine or western art, nor to styles within European heritage.

There is a need of broader Museum and Educational context representation of the western art influences in Macedonian Medieval art and vice versa, its artistic models being followed in Italy. Especially since the westerners rarely could think of any other but Byzantine art within the southern part of the Balkans. It is another wrong opinion, that is generalization, to identify the whole art of the Balkan region in the Middle Ages with Byzantine style. It is a result not only to the old researchers who started studying this culture, but also the local scholars who keep on using the wrong term Byzantine for every medieval artistic expression. There is a need and it is a duty of the curators and educators to give real time presentation and context, with as little as possible politic influences, and to use proper terms and presentation of the art in medieval Macedonia. It has local and original features, due to the Slavic origin and language and mentality of the inhabitants, combined with introduced and accepted or imported artistic influences from Byzantium, Mediterranean region and later, within the post byzantine era, from the West through the mediatory artistic workshops of the Greek islands combined with the still live byzantine traditions. These various influences are mixed with the small scale application of the oriental culture that comes along with the Turkish rule after the late 14th C.

Byzantine culture has been accepted as foreign and in the beginning not appreciated culture as many written works prove, for instance the letters of Ohrid archbishop Theofilact. Apart from the artistic techniques especially in the field of relief and applied arts, there are almost no features accepted from the Islamic culture in the visual arts. This does not go for the food, music instruments and later urban costumes. Folk costumes has never accepted direct foreign influences. Some female head decoration even centuries later reflect the fashion of the high class ladies of the Middle Ages (especially Prilep and Debar) which may have been remembered also through the fresco images of the noble class in the Macedonian churches.

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Turks have turned many large churches into diamies, or put down ecclesiastical objects, build infrastructure, fortifications, but the local folk architecture remained loyal to its roots.

This kind of cultural portrait of Macedonian nation shall be represented in its full diversity within our museum and educational praxis.

Fig. 7. Icon of Virgin with child, Ohrid, Virgin Perivleptos church iconostasis, today in the Icon Gallery, Ohrid, mid 14th C., inv. no. 81.

Fig. 8. Duccio di Boninsegna, Virgin with child and two angels, Crevoli Madonna, 1283-4, Museo dell'Opera del Duomo, Siena.

Fig. 9. Young King Uroš, Visoki Dečani, the family tree of the dynasty, 1347-48.

Fig. 10. Empress Helene Holy Archangel Michael, Lesnovo, 1346-47.

Fig. 11. St. Nicholas, icon, Bari, painted by Kotor painter,1327, gifted to the church by the here represented king Stefan Dečanski and his wife queen Maria.

Fig. 12. Icon of St. Nicholas, mid 14th C., repainted except the face in the 19th C, iconostasis of the church St. Nicholas, Gerakomia, Ohrid,

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Artec Campus

An experience of high professional communication of art in high school

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***Abstract*— Twenty-seven students of Seriate (BG) Ettore Majorana high school were involved in the first edition of "Artec Campus: New Technology for Artistic Storytelling", a 80-hours school/job alternation course within the "RomanicaMente" Project promoted by Associazione culturale Muse.**

Index Terms *school, teaching, Romanesque, artwork, communication*

I. THE CAMPUS

The training program involved the implementation of technical laboratories that enable the use of technologies such as Augmented Reality, web design, visual design and press office skills, social network management and video production.

Img. 1 The class involved in the project in front of the library of Seriate.

Thanks to these activities, high school students - with the support of professionals - have been able to create: (1) a communication campaign managed by an internal press office, (2) promotional videos, (3) a website, (4) a channel dedicated to basso Sebino on the Aurasma app that allows free access to contents of Augmented Reality, (5) promotional materials such as postcards, brochure and flyers, (6) social networks pages and channels (Youtube, Facebook and Instagram) to promote their territory and their experience outside the boundaries of the basso Sebino.

II. PHASES AND ORGANIZATION

The Campus has been articulated in the following phases:

1. Presentation of the project and the working group and agreement with the students for the implementation of the communicative project to be completed within the expected 80 hours.
2. Artistic storytelling with focus on social networks: practical examples and laboratory work.
3. Il Romanico: introduction to the Romanesque.

Analysis of Romanesque evidence in the Basin of Sebino area with focus on the 5 Romanesque Churches object of communication.

4. Designing the Basso Sebino's storytelling promotional campaign.

Preparatory phase: what is a promotional campaign, how it is structured, what tools are used.

Design phase: all students would work together to define the general communication project.

Then any group begins to design for their own specific content and execution modes, with the supervision of the teachers/professionals.

5. Press Office.

Explanation of how to make a communication campaign using registers suitable for each different media (printed paper, web and TV headlines, radio) and how to identify and use all media present in a territory.

6. Augmented Reality.

Introduction to Augmented Reality and illustration of the use of the Aurasma platform for increased content upload.

7. Video shooting.

A lesson about shooting techniques, use of tools and their potential.

8. Video design.

Teamwork design and evaluation of video proposals for the project of valorisation.

After the lessons about the themes and the techniques of communication, the following days are dedicated to a more specific practical work.

Multidisciplinary days

Five outdoor activities for the five groups for the shooting of the churches with the collaboration of the director.

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During these activities the other students who will be remaining in their class will rotate in laboratories:
1. Graphic design and use of related programs.
2. Social network.
3. Developing a site with CMS
4. Press office work.

Production
After completing the training and collecting the relevant information, new groups are created and each one is responsible for a specific area. Depending on the role assigned, the boys work on the following areas:
1. Video editing.
2. Design office.
3. Website creation / augmented reality.
4. Creating pages and social channels.
5. Elaboration and implementation of communication strategy with the press.

Img. 2 A moment of backstage of the video shooting.

The communicative project resulting from the course is presented with a public event on the territory, organized and carried by the students themselves.

III. RESULTS

Thanks to these activities, high school students - with the support of professionals - created:
1. A communication campaign managed by an internal press office based on the idea “We are Romanesque”, being testimonials of the present of art in their territory and a logotype of RomanicaMente.
2. An advertising “We are Romanesque” and 5 videos about the 5 churches.
3. A website: <http://www.romanicamente.it>.
4. Five points of augmented reality in the churches that allow visitors to have a virtual guide on site.
5. Promotional materials: a postcard, a brochure.
6. Social networks pages and channels: YouTube, Facebook and Instagram.
7. A project for an AR game in the churches.
8. A card game based on the saints to whom the five churches are dedicated.

Every product created by the students is now accessible by locals and tourists, providing innovative tools useful to valorisation of territorial assets.

Students have acquired skills strongly linked to their training curriculum that will enable them to approach technologies of high interest to the tourism and cultural sector for the potential of engagement and innovation they are carrying.

IV. PARTNER

Actions by Associazione culturale Muse in collaboration with Associazione culturale Romanico nel basso Sebino, Duccio Agresti videographer, Marco Pucci AR, Silvia Profili press office. The Campus was held in Giacinto Gambiarsio Seriate public library as a partner of the project with the collaboration of the Municipalities of Adrara San Martino, Adrara San Rocco, Castelli Calepio, Credaro, Seriate and Villongo. The project has been financed by Fondazione Cariplo.

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Supporting the network

Innovative approaches to Heritage Education

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***Abstract*— The contribution illustrates the role of the Educational Services Centre (SED) along with that of MiBACT Educational Services Network in the area of Cultural Heritage Education in Italy, and its promotion addressed to all types of audiences, carried out through the potentials offered by the Internet and through networking and project actions.**

Index Terms *heritage education, training, mediation, active citizenship, digital accessibility*

I. EDUCATIONAL SERVICES CENTRE

The tasks of the Museum and Territory Educational Services Centre (SED) pertaining to the MiBACT Directorate-General for Education and Research – Service I, Studies department, involve the coordination of Territorial Educational Services, for purposes of promotion, communication, dissemination of cultural heritage education, in line with the *National Plan for Cultural Heritage Education* (2017)[1].

In planning a cooperative Education Services Network, the Centre elaborates planning content, experimental *formats* and innovative forms of communication thereby contributing – in synergy with various projects and through inter-institutional partnerships – to meeting civil society's growing demand to share the Country's historical and cultural heritage.

II. NETWORKING WITH AND THROUGH THE INTERNET

The MiBACT Network of Educational Services, of central and national Institutes, of independent Institutes of National interest, of Heritage protection authorities, Museum Complexes, Museums, Archives and Libraries is made up of a number of professional figures and structures that, in defining national educational and cultural policies, develop programs with regard to local territories and communities.

Within the area of network planning, the creation of web-based environments is an innovative approach aimed at integrated educational activity featuring easily accessible, state-of-the-art communication, advanced by new content access tools.

III. EDUCATIONAL PROGRAMME

The MiBACT *National educational programme*[2] – understood as a coordinated action ensuring the right to access cultural participation and production systems with a view to addressing the new needs of a new 'educational society' – envisages, in line with the indications provided for in the *MIUR-MiBACT Memorandum of Understanding* (2014)[3] the annual collection, coordinated by SED, of all educational and heritage access activities offered by the Network, free of charge, to all audiences with the purpose of conferring topical relevance to the educational experience whilst ensuring increased synergy between the realms of education and culture.

In the definition of its various goals, content and activities, the projects' implementation envisages didactic tours, articulated programs, work-related learning activities[4], apprenticeships, refresher courses for teachers, artistic, technical, multimedia and communication workshops, etc.

IV. NETWORKING PROJECTS

IV.1. DISCOVER YOUR MUSEUM

Discover your museum is an educational museum heritage project encompassing 40 museums and their historical, artistic, archaeological, ethno-anthropological collections presented through *thematic maps* with simplified texts and

[1] Il Piano Nazionale per l'Educazione al Patrimonio Culturale, Direzione Generale Educazione e Ricerca, Ministero dei Beni e delle Attività Culturali e del Turismo.

[2] See: <http://wwwww.dg-er.beniculturali.it; database on <http://www.sed.beniculturali.it/>, accessed 22 June 2017.

[3] Protocollo d'Intesa tra Ministero dell'Istruzione, dell'Università e della Ricerca ed il Ministero dei Beni e delle Attività Culturali e del Turismo "Creare occasioni di acceso al sapere attraverso la messa a sistema di istruzione e cultura al fine di sviluppare una società della conoscenza" – 28 maggio 2014.

[4] E. Borgia and M. De Luca, "Il Portolano dell'alternanza scuola-lavoro nei luoghi della cultura", Direzione Generale Educazione e Ricerca, Quaderni, 1, 2016.

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attractive graphics describing the most important objects, with pictures, legend and location. Target: 6-12 years, families, teachers, non-expert audiences. It provides a brief overview of the professionals working in the museum, along with information and news on physical accessibility. It provides for the active participation of visitors who have the possibility of expressing their opinion on their experience *online*.[5]

IV.2. ACCESSIBILITY AND PARTICIPATION THROUGH A WEB RADIO

Illustrating cultural heritage without seeing it, conveyed through the whole range of potentials offered by a web radio, is the spirit marking SED's cooperation with the Italian Union of Blind and Visually Impaired persons in the radio project *Art Conversations*, launched in 2011. The goal of the program, involving MiBACT experts and scholars, and those of other Institutions, is to spread knowledge on the heritage and raise awareness on accessibility to cultural heritage. This program broadcast by Slash Radio Web, with live streaming on the dedicated Facebook page, provides interaction with listeners and is enriched with information on activities accessible by visually impaired persons.[6]

IV.3. ONLINE ACTIVE CITIZENSHIP TOOLS

The project and national contest *Article 9 of the Constitution* lies within the framework of Education to active citizenship, designed for educational establishments of all levels. The purpose of the project is the promotion of a responsible, proactive approach towards cultural heritage and scientific research.[7] The technological tools adopted therein enable *online* sharing of didactic materials and contributions elaborated by pupils. The video-recording of approximately one hundred conferences, broadcast in streaming, along with the manifold didactic visits to cultural sites are available on the website www.articolo9dellacostituzione.it, which emerges as an area of information, learning and encounter of participants through social network profiles.

IV.4. DIGITAL CULTURAL HERITAGE, ARTS AND HUMANITIES SCHOOL

Set against the backdrop of *Creative Europe*, the digital platform is considered one of the major themes of cultural projects for the period 2014-2020, understood as a paradigm and a global approach with regard to cultural heritage, capable of ensuring – by extending beyond traditional fruition solutions – the re-configuration of contemporary cultural practice. In fact this is the horizon of the *Memorandum of understanding* (2016)[8] involving the Directorate General of Education and Research and the Digital Cultural Heritage, Arts and Humanities School[9] aimed at putting into action educational methodologies and acquisition of skills in the area of *Digital Cultural Heritage*. Thanks to the identification of shared interventions (activating a community, implementing contests with a view to advancing 'cultural ownership', engagement of youths, etc.), the overarching goal is to contribute to the creation of a digital knowledge design applied to Heritage education.

CONCLUSIONS

In the area of cultural heritage education – understood as a global approach – the Network is called to adopt increasingly effective tools in support of information and data dissemination. The contribution of modern technologies to our present 'knowledge-based society' enables the development of multimedia products, interactive learning, dynamic show-casing, to the benefit of various forms of cultural restoration and in-depth education, but basically, it allows the implementation of shared, accessible tools for all audiences

Img. 1. Naples, Royal palace of Naples. Enjoy Royal Palace: QR code app for visiting itineraries. One of the MiBACT National educational programme's related project

[5] For download log on: <http://www.se.beniculturali.it>; <http://www.focusjunior.it>, accessed 22 June 2017.

[6] Available on the websites: <http://www.uiciechi.it; <http://www.sed.beniculturali.it> under the item 'Progetti', accessed 22 June 2017.

[7] Promoted since 2012 by the Minister of Education, University and Research; Benetton Studies and Research Foundation; Ministry of Cultural Heritage and Activities and Tourism along with relevant cooperation and media partners.

[8] Protocollo d'intesa (18 febbraio 2016) tra la Direzione Generale Educazione e Ricerca, Ministero dei Beni e delle Attività Culturali e del Turismo e Digital Cultural Heritage, Arts and Humanities School (DiCultHer) – "Il patrimonio culturale esiste solo quando è riconosciuto come tale" (REP. Decreti 19/02/2016 N.111).

[9] DiCultHer (<http://www.diculther.eu>) includes over sixty members including Universities, Research bodies and organizations that represent a network of highly-skilled experts in this field operating through a reticular structure consisting in Educational Centres.

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Look, think and talk about art and heritage to better understand the world

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***Abstract*— The Artwork as an element of Cultural Heritage, with its intrinsic values, allows to go depth the complexity of the world and to the essence of the Human Being, through practices that encourage self expression and promote significant learnings, to increase the culture of thinking, inclusion and integration. Practices gradually consolidated, in educational, cultural and social contexts. From this perspective, the Visual Thinking Strategies (VTS), is an interesting an useful methodology and the core of the experiences that we are developing in different contexts.**

Index Terms *art, heritage, education, appropriation. inclusion*

I. HERITAGE AS VALUE

The Artwork, as an element of cultural and social Heritage, as a metaphor, with its multiple meanings, ambiguities, mysteries… allows to approach the complexity of the world, and Human Being, through the evidences and questions that artworks raises.

This approach to Art and Heritage, as Human Beings, from our own eyes, not through the eyes of others…, to know and express what we feel, what we like, what interest us, what make us think, activates a process that facilitates the creation of our own stories, links and attachments with Heritage. Of course it is a people right, because these kind of experiences are essential for the growth of every one, but still too often a privilege for many people.

In this sense experiences with Art and Heritage as opportunities to explore, analyse, inquire, argue and share feelings, emotions and thoughts, from our own references, through a respectful dialogue and exchanging knowledges, make possible to become aware of:

- what is perceived through the senses,
- what is felt through the emotions,
- what is thought and know through the reasoning...

And with these experiences begins a process and a series of connections that allow:

- to know us better and to deepen in a better understanding of what surrounds us,
- to active the process of giving value, identity and meaning to heritage,
- to contribute to a respectful attitude, commitment, involvement in the conservation and preservation of culture and heritage.

By this way of doing, that gives priority to the personal experience, offering space and time to look, think, listen and communicate, emerges the value of the well done observation, the well expressed word, the well reasoned thought, from the respectful dialogue, the engaged participation and the enriching interchange.

This means that, approaching to Heritage meanings, should be, not only to know and pass on accumulated wisdom, but to give voice to new visions. Because we need all these ways of seeing the world, because it enriches today's society and ensures the future growth.

These are some principles that Visual Thinking Strategies, VTS, promote with the methodology and of course, they could be one of the best ways of contributing to improve and dignify the ways of doing and thinking of our society.

Visual Thinking Strategies use the Artwork to learn looking, thinking and communicating, and has become a practice to develop verbal and communication skills, to increase the critical and creative thinking and encourage integration of the social and cultural diversity. And this is what we need.

From this perspective, the Artwork, the visual image, as an educational tool and the Visual Thinking Strategies (VTS), − thought and language − as a methodological resource, are the core of the experiences that I will like to share.

II. SOME EXPERIENCES USING ART HERITAGE AND VISUAL THINKING STRATEGIES

1) Let's grow with Art !

a) The VTS in a Highly Complex School.

We have implemented a VTS program within the framework of a Tandem Project, driven by the Museu Nacional d'Art de Catalunya, (MNAC) to promote educational success. The project has led the M. Bleach School from Barcelona, with a 99% of emigration and social exclusion risk, to a significant methodological change, where, work by projects, Art and Heritage, VTS Program and community involvement, have been the center of teaching and learning. As well as a deep reflection on the educational models used between the team involved.

With the project, the Art has gone to the School, and in the way, the Visual Thinking Strategies, has been an important tool to grow up student's, teacher's and trainer's competences.

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And with the process of this three years, the School has gone to the Museum, and it has become a familiar place for everyone, pupils, teachers, families…, And the most important, a place to enjoy, explore, discuss, express thoughts and feelings, share ideas, discover meanings…

b) Growing with the project.
Regarding the implementation of the VTS Program, we can say that we have obtained some very good results because we have learnt a lot, especially issues related to teaching and learning. This has been thanks to the involvement and efficiency of all agents and the interesting process of teacher's training. Including the role of the third year trained teachers to introduce the new ones into the VTS basis, to ensure the continuity of the program, as a singularity of the School Pedagogical Project. At the same time the it has been a good way, to deepen in the theoretical aspects of VTS methodology and to be aware of the multiple possible applications[1].

2) Museu Nacional d'Art de Catalunya, MNAC, as a cultural scenario with educational and social responsibility

The use of VTS in a museum, like the MNAC, could be determinate by the purposes of the Museum itself as Institution, the Collections, the focus approaches of the Educational Departments, the educators profiles, the kind of audiences…, between other variables.

The experience carried out with M. Bleach School with the systematic use of the VTS in this context of maximum diversity on the one hand, and the museum educators, special VTS training on the other, allows to compare attitudes and behaviours of other similar schools and other museum educators that have not done VTS, when they are looking at Artworks in the museum's rooms. This observations have provided relevant information and a lot of inspirations and about the profiles of museum educators and about the possibilities of VTS methodology with different purposes.

Now the researches started long time ago are more alive than ever and the debate is focused on new ways to bring Art closer and significative to different audiences, the value of the Artwork for Human Being development, and specially trying to rethink the museum roles in today's society.

3) VTS in Master Program Studies

We use VTS and Artworks to reflect about Physical and Social Environment issues, in a Master Program focussed on Management, Urban Intervention and Environment Education in Barcelona University. The practice has been an useful tool for the Master Students of different professional profiles, to develop skills to connect in a free way with the environment, to increase the ability to identify meanings, to diagnose rigorously the problems, to lead and manage efficiently Environment, Heritage and Urban issues.

In this context, if historically Environmental Education emerged as a need to prevent Earth problems, as a result of human actions, to raise awareness about conservation and preservation, today following this tradition, in front of the unstoppable increase of the urban population, we should focus Urban Education and Urban Culture as a independent practice.

"The future of the city depends on the ability to understand it from the different sectors and the ability to take this scenario as a place of securities, certainties and uncertainties" (Joan Nogué, geographer, 2006).

Thinking about Heritage, Environment and Urban issues, as physical and social main subjects, we consider Urban Education, the practices that generates values, attitudes and behaviours favorable to the understanding and the sustainability of the city, as a basis for appropriation, creating links and building the identity of the place.

This challenges require Civic, Urban, Environment and Heritage Education, that integrates knowledge of the city, through an active process as a citizen, to be aware about the essential issues...

In a more specific way, we can highlight, as Urban Education, proposals, initiatives, activities aimed to promote:

- Experiences that allow to become aware and to reflect on the relationship, use and appropriation of spaces, such as places of life;
- Significant knowledges to understand better the complexity of the city, as a physical and social entity, to become more aware of the facts, beyond the influence of media and to be able to act accordingly. Values**,** habits and attitudes, to ensure the development of a critical and active citizenship, respectful and engaged, responsible and participatory, with rights and duties;
- Practices that increase the skills to identify, analyse situations, diagnose different realities rigorously, resolve conflicts from the consensus, make meaningful interventions and manage the environment with rigor and efficiency.

Following this purposes, we have applied VTS methodology as a resource to improve Environmental Education and Urban Culture. We can conclude by saying that the practice of VTS in this specific context, between experts in different subjects, but related with Physical and social issues, is an interesting activity. For those that are closer to technical disciplines, as well for those working in psychological fields.

As we have verified, the practice allows to emerge feelings, thoughts, arguments, ideas, positions, hard to emerge in other situations. In this context Artwork releases from the domination of reality to seek new associations that can be used to expand the vision about issues, to flexible thinking in order to act more fairly and efficiently.

4) VTS to improve Social Issues

a) The VTS as a tool to improve a new language to better integration.

In this context Artwork, Heritage and VTS methodology is used as a resource, promoted by the Government of Catalonia, to increase verbal communication skills on Catalan language,

[1] Learn more about issues presented, from the blog.museunacional.cat.

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with adults from diverse origins to feel more integrated in Catalan society and to have more opportunities to find jobs.
b) The VTS to develop communication skills with mental disable people.

In this context, Art and VTS methodology is used as a tool to improve the self-esteem and self-confidence of metal disabled people, to improve their capacities of express themselves and to communicate between them, with the purpose to promote social and professional inclusion and to help them to find jobs in companies with social responsibility.

Both experiences are being very positive, because the opportunity to express themselves during VTS sessions freely and spontaneously and to feel listened when they are talking about their own stories, improve their behaviour in other contexts. This is an small contribution, but helps many people to go ahead with their difficulties.

III. FINAL THOUGHTS

We want to focus our attention on the importance of encouraging dialogues and connections, between Heritage and Human Being, as one of the issues in a Conference about Heritage and Education.

But beyond Art, Heritage and Educational purposes, that weave realities and metaphors, values and conventions of each culture, with different meanings and interpretations, as we said at the beginning of this presentation, we want to highlight the practices, such as Visual Thinking Strategies, that provide opportunities to look, think, and talk, slowly and without pressure. Because from these proposals, could emerge the value of the curious watching, but rigorous; the spontaneous word, but well expressed; the creative thinking, but well argue, the listening respectfully, but engaged; the uncomfortable confrontation, but enriching... All that to better understand ourselves and the others and to have a better understanding of the world. And according to these principles, to become an active part of social transformation, through Art and Heritage and promoting the “Culture of Thinking" for all.

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To Philip Yenawine for validating the project implemented in the Miquel Bleach School of Barcelona with the Museu Nacional d’Art de Catalunya and encouraging us to continue with the Program.

To the Education Department of National Art Museum of Catalonia, to involve me as a collaborator in the Tandem Project, to assess the implementation of the VTS Program, and to conduct the School Teachers Training and the Museum Educators Training. In addition having the opportunity to do a careful teacher's monitoring during the three years of the application, with the role of coach, has been a great personal and professional enrichment.

These experience has increased my knowledge about how to improve VTS training and has allowed me to go further in the theoretical methodological contents.

To the Museum Educators for their interesting questions emerged during the VTS training practices, that allowed to raise how to manage in the museum context, the tension generated between the academic and historical interpretation and the visitor’s stories.

To the Miquel Bleach School Management Team, for their availability and efficiency in the organization of training meetings, sessions schedules, places to carry out the programme...

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Making prehistory more accessible with digital heritage

The use of 3D technologies in museum exhibition and education

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***Abstract*— Folsom-age (10,800 - 10,200) hunter-gatherers were the quintessential travelers in North American prehistory. They annually crossed hundreds of miles on foot following ancient bison herds. The stone tools that they crafted to hunt and butcher these ancient bison were some of the most exquisite and technically complex tools ever made in the Americas. The exhibit "Engaging Folsom (10,800 - 10,200) Hunter-Gatherers with 3D Technologies" was developed for the Lubbock Lake Landmark Interpretive Center that incorporated the use of 3D technologies that enable visitors to experience the extreme thinness, portability, and versatility of Folsom stone tools. A variety of Folsom objects and bison (ancient and modern) bones were 3D printed for the exhibit. The tools and bones were 3D modeled using digital photogrammetry. Then, the 3D files were 3D printed. Tools included Folsom projectile points, ultrathin knives, and Folsom blanks to show how the tools were made. Examples of ancient and modern bison bone showed how bison have changed size through time. Incorporating 3D printed objects in exhibits encourages direct, tactile interaction for visitors. 3D technologies are rapidly changing the face of exhibits, documentation, and research, at museums. During exhibit planning, other technologies were incorporated into the exhibit to increase accessibility. Each 3D printed object received a 3D printed braille label both on the object and separately, next to the traditional text label. In addition, a unique voice message about each object was recorded onto a Raspberry Pi microcomputer that plays whenever the object is lifted off a copper plate. The integration of 3D technology into this exhibit has brought an increase in the number of visitors to the Landmark interested in both technology and the prehistoric past. Research is ongoing to explore the impact of 3D digital heritage on education and visitor experience.**

IndexTerms *Folsom hunter-gatherers, photogrammetry, 3D printing, museum exhibition*

I. INTRODUCTION

The Lubbock Lake Landmark is a 136 hectare archaeological and natural heritage preserve located in Yellowhouse Draw of the Southern High Plains physiographic province within the city of Lubbock, Texas (Fig. 1). The Southern High Plains is a flat 130,000 km^2 grassland plateau [1]. Discovered in 1936, Lubbock Lake is designated as both a State and National Landmark [2]. The significance of the Landmark is its continuous record of prehistoric hunter-gatherer and historic occupations over the last 12,000 years.

The Landmark's mission is to provide leadership through stewardship, research, and education to reveal cultural and natural heritage for the public and scientific communities. To fulfill this mission, the Landmark regularly offers public programs −both routine and special, participates in outreach activities, utilizes volunteer assistance in both education and research, maintains permanent exhibition galleries and a temporary gallery that rotates annually, and produces public reports and peer reviewed works. The integration of research, education, and community outreach is a guiding principle for the Landmark. This principle fosters a culture of visitor centered practice at the Landmark and paved the way for the innovative Folsom Hunter Gatherer exhibit.

Rapid advances in 3D technologies and computer processing power over the last decade are transforming how research is documented, analyzed, and presented to communities. Both laser scanning and photogrammetry are now more affordable and easier to use. Researchers and educators increasingly are using these methods to capture cultural heritage as 3D models [3]. These 3D models also are easier to share via the Internet through services such as Sketchfab. The proliferation and decreasing cost of 3D printers is making it easier to share 3D printed objects [4].

The exhibit "Engaging Folsom (10,800 - 10,200) Hunter-Gatherers with 3D Technologies" was developed incorporating these technologies. It opened in November 2016 for a year run. The challenge in this exhibit was to use 3D technologies in public engagement to enhance their experience in interpreting how Folsom people lived over 10,000 years ago. A combination of photogrammetry and 3D printing was used to replicate Folsom-age objects that visitors could hold in their hands. In addition, increased accessibility to the exhibit was accomplished by adding braille text to 3D models and labels. Capacitive touch sensors activated audio descriptions of each object to improve the experience of visually impaired visitors.

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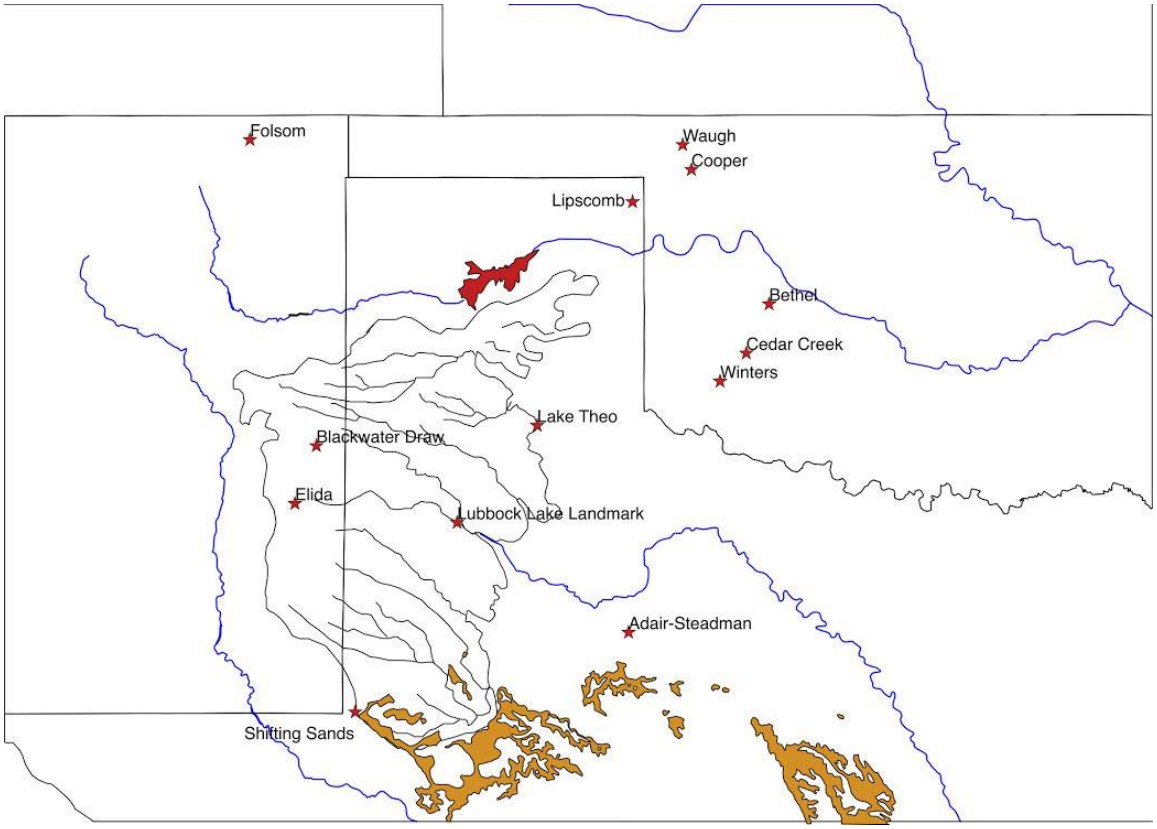

Fig. 1. Location of Folsom sites on the Southern Plains.

II. FOLSOM PEOPLE ON THE SOUTHERN PLAINS OF NORTH AMERICA

The Folsom cultural time period was named after the Folsom site discovery near Folsom, New Mexico in 1926 [5]. Fluted stone projectile points were used to kill an extinct form of bison (*Bison antiquus)*. With over 15 Folsom sites identified across the Southern Plains of North America, radiocarbon ages indicate that Folsom was one of the oldest hunter-gatherer time periods in North America. Folsom people were highly mobile travelers. These hunter-gatherers regularly traversed a territory over 480 kilometers following ancient bison herds across the Southern Plains. Folsom hunter-gatherers developed an elaborate stone tool technology to transport and craft stone into tools. They relied upon flaked stone for making cutting, scraping, drilling, piercing, and projectile tools. Folsom flintknappers excelled at making extremely thin bifaces and projectile points for minimizing weight while maximizing the amount of potential tool uses.

Bifaces are pieces of stone that are shaped on both sides, are multifunctional tools like today's Swiss army knife. Bifaces can be used as cores for removing sharp flakes useful as tools themselves or further shaped into other tool types, and also are hand held tools for butchering and cutting tasks. The bifaces themselves can be further shaped into other tool types such as projectile points when needed.

Folsom flintknappers made extremely thin bifaces known as ultra-thins. Ultra-thin bifaces had a width-thickness ratio of 8 to 1 or greater. Making ultra-thin bifaces required a lot of skill to not break the bifaces in half while removing thinning flakes. Ultra-thin bifaces were light weight, portable packages for supplying raw material for making tools, and used as tools themselves.

Folsom flintknappers also made extremely thin projectile points by fluting one or both sides. Fluting was the process of removing a large channel flake from the base of a projectile point for thinning. Fluting was risky, with an estimated breakage rate 1/3 of the time. Nevertheless, Folsom flintknappers likely fluted for a secure haft fitting, and this design has been demonstrated to absorb shock to minimize projectile point breakage on impact [6,7].

The Lubbock Lake Landmark regional research program has been investigating Folsom hunter-gatherer lifeways at the Lubbock Lake Landmark and Adair Steadman (Fig. 1). Adair-Steadman is located 192 kilometers downstream from Lubbock Lake, both within the Brazos River drainage system. Investigations at the Landmark have uncovered a series of Folsom bison kills and butchering areas, and a stone tool workshop at Adair-Steadman. The exhibit focuses on exploring how Folsom people from Adair-Steadman to the Landmark made their

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stone tools, moved across the landscape, and hunted ancient bison.

III. METHODOLOGY

Making stone tools was a reductive process. A Folsom projectile point preform, ultra-thin biface, and projectile point from the Adair-Steadman lithic workshop were chosen for 3D modeling as examples of this process, and to illustrate how Folsom flintknappers were able to craft very thin and sharp portable stone tools. To demonstrate the difference between ancient (*Bison antiquus*) and modern bison (*Bison bison),* metatarsals (fused foot bones in bison) were 3D modeled to show how bison changed and became 30% smaller in size over time [8]. Besides stone tools, Folsom hunter-gatherers also modified bison bone during the butchering process to create expediency bone tools to aid in butchering. An expediency bison butchering tool from the Landmark was 3D modeled.

Agisoft Photoscan software was used for creating the 3D photogrammetry models. The Folsom objects were photographed within a light tent for getting consistent image results. A Nikon D7100 24 megapixel camera was used for imaging. Each 3D model was scaled to ensure accuracy and that no holes, missing, or inverted triangles for 3D printing occurred.

Braille text was created with the 3D printing software MatterControl. The 3D models and braille text then were combined and merged with Tinkercad software. The placement of braille was vital. The location could not obscure an important feature of the object. For the braille to be legible, however, it had to be placed on a flat surface to ensure that the height of each dot is the same. Because the exhibit objects had irregular sizes and shapes, they did not necessarily have a flat surface for braille placement. If no flat surface existed, the rectangular label was left underneath the braille to provide an even plane (Fig. 2).

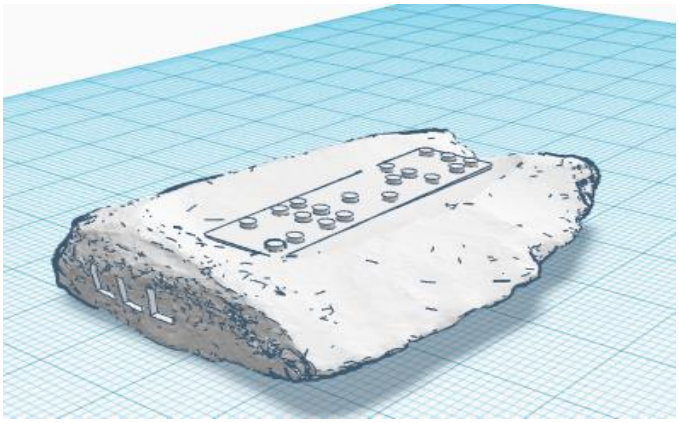

Fig. 2. Placing Braille text on Folsom projectile point preform within flute.

The label was submerged into the object as much as possible to minimize the appearance of the label on the resulting 3D print. Tinkercad also was utilized to add a copyright logo to each object. LLL (the abbreviation for the Lubbock Lake Landmark) was sunk into the 3D models and strategically placed to avoid masking any important features.

A LulzbotTaz 5 was used for 3D printing, and the open source Cura software was used for managing print jobs (Fig. 3).

Fig. 3. 3D printing ancient bison metapodial with Lulzbot Taz 5.

Cura allowed for fine-tuning of multiple printer settings, including layer height, print speed, the orientation of the object, support material, and temperature settings. Experimentation with these settings was critical. Because the exhibit team prioritized quality of the 3D printed objects, the settings were adjusted to maximize quality regardless of how much time the print time increased. For example, the ultra-thin biface print time increased from 6 to 20 hours to maximize quality. After weeks of prototyping, the main settings were finalized, and then repeated for each object that was printed. The only settings continually adjusted were the object orientation and support material. Each object necessitated its own specific orientation and support settings because of their varied shapes and braille placement. Braille printed quality was much higher when positioned vertically on the build plate.

Post-processing included the removal of support material manually or chemically. For this exhibit, only support material removal, sanding, and vapor smoothing were completed. Some of the 3D printed objects underwent a cold, acetone vapor bath to smooth out sanding marks. Smaller objects required less exposure while larger objects required longer exposure times.

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Fig. 4. Folsom projectile point preform on top of capacitive touch sensor that play an audible description when lifted.

Raspberry Pis (a small yet powerful computer, roughly the size of a credit card) were incorporated into the exhibit as a cost-effective way to power capacitive touch sensors (Fig. 4). Raspberry Pis were used to play a recorded audio message about each 3D printed object when lifted off the touch sensor. Other than the bison metatarsals, each object rested on its own, separate touch sensor and its own dedicated Raspberry Pi. The bison bones shared a touch sensor and Raspberry Pi. This decision was made to give visitors the best experience. Separating the objects onto stand-alone pedestals allowed for placing the objects near relevant text panels and ensured greater simultaneous access by multiple visitors.

IV. DISCUSSION

A 20% increase in the number of visitors has occurred with the opening of this Folsom exhibit. The Landmark's education program provides K-12 learners with alternative curriculum to structured traditional learning through specialized events (e.g., American Indian Heritage Week, Environmental Awareness Week), classroom field trips, and topic specific traveling trunks. This exhibit is incorporated into these educational programs, and provides an experience for all age groups. At first, visitors have been hesitant to interact with the 3D printed objects. To encourage interaction, the object labels have been updated to include this phrase "Please Handle and Return." Visitors now frequently are observed touching the objects and listening to the audio messages.

An initial concern for the exhibit was that the 3D models frequently would be broken or go missing. For the first four months of the exhibit, no objects were broken or went missing. Since then, the ancient bison metatarsal was broken twice — once along a weak spot in the print, and once along the "LLL" logo. Both times, it was epoxy glued back together. The 3D models also can be reprinted if lost or broken beyond repair.

Emphasizing increased accessibility through a participatory experience did not stop with the exhibit design. This objective also guided the special educational programming offered in conjunction with the exhibit.

Thus far, programs were organized for High School students, families with children who are on the autism spectrum, and general Landmark visitors. To increase understanding of and familiarity with 3D modeling and 3D printing, a two-part workshop was developed. These workshops "Making 3D Models with Digital Cameras" and "Design Your World! – Computer Aided Design and 3D Printing" were offered free of charge to any interested individual regardless of age.

Previous knowledge of either subject was not required and the Landmark provided laptops and cameras for the participants to use. Each participant left the workshops with instructional material and a 3D printed Landmark themed coaster. The workshops received positive feedback from participants, and this feedback is being used to develop more workshops for a variety of adult and child learners.

The Landmark also partnered with a Texas Tech University student engineering group to host a cultural heritage themed hackathon (Fig. 5).

Fig. 5. High school students designing an atlatl shaft to fit a Folsom projectile point.

In hackathons participants worked collaboratively to solve problems and come up with new solutions. This event engaged high school students with Folsom cultural heritage and provided an opportunity for pressure free, college student led mentorship. The hackathon challenge was to design a 3D model of a Folsom atlatl shaft. The students received an overview of Folsom people's lifestyle, and their technology. The students then broke into teams, explored the Folsom Hunter Gather exhibit, practiced throwing atlatls, and studied a life-size bronze statue of an ancient bison. Within a few hours, each group had a fully designed 3D model and prepared a written spec sheet. Each design was 3D printed and then Landmark staff selected the winning design. The winning design was placed on display next to the Folsom 3D printed point so visitors can simulate assembling Folsom hunting technology. This interdisciplinary event tapped into the high school student's curriculum based knowledge, but also physically placed them within the cultural landscape during the learning and design process. These types of workshops not only provided opportunities for visitors to learn a new skill, they also highlighted how the Landmark is using 3D technologies to improve the visitor experience. The use of 3D technology expands the exhibit beyond the gallery walls into the elementary school classroom through traveling trunks. Trunks are designed to provide classroom teachers with

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materials that enrich curriculum. The *Paleoindians on the Southern High Plains* trunk contains the same 3D printed objects from the exhibit along with lessons and activities that introduce Folsom Hunter-Gatherers and the past landscape. Teachers are encouraged to keep the 3D printed objects for further use in the classroom.

The exhibit received a 2017 Texas Association of Museums Media Innovations and Excellence Award for the incorporation of new technologies in exhibit design. A website currently is in development that will further take this exhibit outside of the museum with interactive computer 3D models and built in accessibility features.

A survey of visitor experience with the 3D models has been implemented to acquire research data on the effect of these 3D technologies on visitor experience and visitor perceptions. Observation evaluations, a pre-visit questionnaire (digital format), and a post-visit questionnaire (paper based) are being used to gather the data. The surveys will remain accessible until the run of the exhibit.

V. CONCLUSION

Reduction of barriers to the displayed objects gives the visitor more ownership of his/her experience. The incorporation of 3D printed objects enables the visitor to interact with the exhibit in a new way while the opportunity to experience Folsom technology allows a visitor to gain a better understanding of the past. This democratization of the exhibit experience helps establish a participatory environment at the Landmark. The 3D printed objects allow for user-driven interactive experiences. The visitor sets the duration of the interaction and decides how to interact with the object. When this interaction happens, either individually or as part of a group, an environment is created for personal meaning making.

Providing an exhibit with a participatory environment that visitors can interact with and touch is an evolving direction for museums [9, 10]. The technologies used in this exhibit are very flexible and affordable for most museums, and can be accomplished in-house by institutional staff members. The Folsom Hunter Gather exhibit is not the only way to use photogrammetry, 3D printing, or Raspberry Pis. Rather, it is a beginning for the integration of these technologies into public education initiatives.

ACKNOWLEDGEMENTS

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Archaeological museums as environments of informal and non-formal science and technological education

The case of Educative Islets

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***Abstract*— This article proposes an innovative museographic solution, the "Educative Islet", which aims to insert Natural Sciences and Technology (NST) elements into an archaeological museum environment. More specifically, it attempts to present the theoretical framework and methodological tools for its design giving an example based on a specific exhibit of the Archaeological Museum of Thebes, as part of a research for further development and evaluation.**

Index Terms *archaeological museum, didactics of natural sciences, museographic transposition, educative islet, interdisciplinary*

I. INTRODUCTION

Museums in the 21st century increasingly tend to enrich their role. Examining the museums in the modern competitive age of the 21st century, one finds the effort to be transformed into wider cultural, research, educational and entertaining institutions, linked to the community and financially independent, aimed at upgrading the experience [1]. Museum pluralism at the level of architecture, administration and operation reveals the symbolic character and the social dimension of the mission of the museums, beyond the traditional obligations of conservation, validation and enrichment of the cultural heritage [2].

Taking into consideration the international and especially the European circumstances in terms of an interest's turn towards alternative ways of cultural heritage promotion, in combination with the fact that archaeological museums are already contributing to a powerful international Greek brand name, examining them from the Natural Sciences and Technology (NST) point of view broadens the knowledge spectrum that derives from the museum environment and makes them a tool of multiple readings.

II. ARCHAEOLOGICAL MUSEUMS AND NATURAL SCIENCES

The archaeological museum can function as an attractive and intimate setting, as a motive for fields of knowledge of NST beyond the narrow traditional boundaries of History and Archeology [3]. NST are able to be in the spotlight, not in terms of a secondary role, but supplementary, for the reconstitution or the promotion of the historical identity of a historical period (in our case of the ancient Greek culture period), that also projects themselves on today's world, of a region or a community. Dealing with notions of natural sciences through the archaeological exhibits and in general the environment of an archaeological museum and its collections can bring more immediate results, since the objects offer visual and tactile stimuli from the material culture of the past, which can act as a more intimate beginning.

But how could we create "bridges" between fields that at first sight seem to have enormous epistemological and cultural differences? We believe that education, and in particular its interdisciplinary dimension, can offer solutions to the museum environment. Many museum workers (especially those in the education department) see museum exhibitions primarily as a method of education. For many museologists, museum exhibitions are educational, and it is always useful to consider the educative value of any exhibition as one important criterion for its success [4]. It has also been pointed out that the appropriate design of a multisensory, educational environment contributes to the building of critical thinking, to the equipment of the public, including children who are the future adults, with analysis and interpretation tools of a complex world, with tools of understanding the past and the present [5], so that they could contribute to scientific culture formation too [6].

This article proposes an innovative museographic solution, the "Educative Islet", which aims to insert NST elements into an archaeological museum environment.

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More specifically, it attempts to present the theoretical framework and methodological tools for its design giving an example based on a specific exhibit of the Archaeological Museum of Thebes, as part of a research for further development and evaluation. We thus exploit the use of the methodological tools of formal education, in the museographic design of an interpretative framework of a museum exhibit, in order to teach the concepts of natural sciences.

III. THE CONCEPT OF THE EDUCATIVE ISLETS IN THE MUSEUM

Educative islet is a movable structure that creates a temporarily interdisciplinary educational micro-environment, designed around a specific archaeological exhibit, providing multisensory educative tools for acquiring scientific knowledge. It may contribute to scientific culture formation and to the building of critical thinking, with analysis and interpretation tools of a complex world, with tools of understanding the past and the present.

The educative islet extends the concept of star exhibits. Exhibitions can be arranged predominantly around outstanding objects when the exhibitor wishes to engage visitors with star exhibits before drawing their attention to less immediately striking ones (Fig.1). Star exhibits have a dual role: they enliven the areas around them, and also tend to draw visitors through a gallery and create a sense of expectation throughout the journey [4].

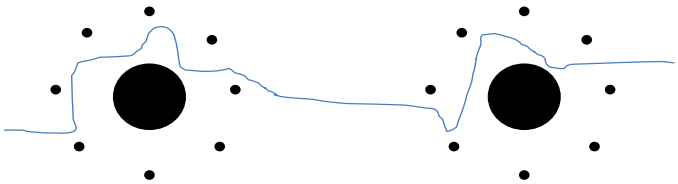

Fig 1. Educative islet as a star exhibit and the movement of the visitors.

The portability of the assembled educative islet allows for the proper configuration of the area around the exhibit to cover the needs of the group during the visit to the museum space without requiring re-designing of the whole exhibition with new permanent museographic intervention and without excluding a more abstract or other kind of interpretive framework for adult audiences. The term "islet" is inspired by the "îlot de rationalité" concept introduced by Gerard Fourez to describe the idea of a degree of knowledge in the midst of an ocean of ignorance within formal education [8].

For the design of the educative islets it is required the implication and the scientific osmosis of three theoretical fields: (a) of Museology, (b) of Science Communication, and (c) of Didactics of Natural Sciences (fig 2).

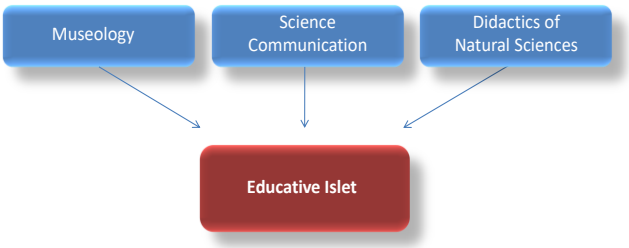

Fig 2. Theoretical fields that contribute to the formation of the Educative Islet concept.

From the wide and varied field of museology, we choose to draw on the theoretical elements related to the concept of museographic transposition which will determine the museographic character of the knowledge to be disseminated. Museographic transposition describes the process when an object of knowledge contained in scientific or an interdisciplinary literature and other sources is transformed to an object of knowledge contained in a museum exhibition [9, 10]. This concept has been used as an analytical or synthetic tool in describing and understanding the process of analyzing or constructing an exhibition, especially in museums of natural sciences. We believe it could be successfully applied to the development of museum environments such as educative islets which, on the one hand, contain interdisciplinary knowledge to be disseminated to the public and, on the other hand, require simultaneous processes of epistemological development and museum-pedagogical development.

The field of Science Communication will mainly determine the epistemological character of the knowledge to be disseminated. The study of the different forms of interdisciplinary processes and products is a prerequisite for the construction of an educative islet [11]. Particularly, the "conceptual bridges" between the collections, the exhibits or the interpretations that the archaeological museum seeks must be studied, as well as the NST knowledge that may be related to all above. Such interdisciplinary fields may be (a) physics methods that contribute to archaeological research such as conservation and dating of objects or archaeological geophysical research; (b) material science and ancient Greek technology; and (c) the relations between ancient Greek art and modern science.

Finally, the field of Didactics of Science will determine mainly the pedagogical character of the knowledge to be disseminated. In this field we will mainly identify two theoretical strands. The first is about the ability of students of various educational levels to develop cognitive and emotional progress in informal or non-formal educational environments, such as museums, and the second is related to contextual science teaching, an educational context where learning is achieved through the connection of the new knowledge within a social, historical or aesthetic context that is intended to facilitate it [12].

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IV. THE ARCHAEOLOGICAL MUSEUM OF THEBES AS A FIELD OF DEVELOPMENT, APPLICATION AND EVALUATION OF EDUCATIVE ISLETS

Although the design and development of educative islets could be carried out in all Greek archaeological museums, the choice of the Archaeological Museum of Thebes is based on the fact that the time line covering all the exhibits of the new museum exhibition provides a panorama of Ancient Greek civilizations through the material remains of excavations [13] from all over Boeotia. This allows the selection of appropriate exhibits offering cross-bridges to connect them to the concepts of natural sciences. The exhibition of the Archaeological Museum of Thebes consists of collections of vases, jewelery, sculptures, coins, weapons, architectural pieces, etc. which cover a wide chronological range, starting from the time of the stone and reaching to the newer years. The exhibits of these collections are related to concepts of NST, offering a fertile ground for their understanding both by the general public and by students, as many of these concepts are included in the curriculum of various educational levels or appear to be suitable for cross-sectional extensions within the framework of the school curriculum, as has already been done in the design of the educational programs at the regional Museum of Thespies [14].

The designing of educative islets belongs to the developmental researches and is based on four consecutive stages: a. Analysis (object-exhibit, museum environment and target audience); b. Identification of the teaching objectives of the NST; c. Design of educational islets and d. evaluation. We then describe roughly an example of the designing of an educative islet for the analysis phase. Around the jar of the Bronze Age, an educative islet entitled "How and why were made the vessels of the 2nd millennium BC?" could function. The target audience for exploiting the educative islet is elementary school students. Indicative fields of NST knowledge arise from the analysis of the medium-sized copper-colored “pithos”: (a) material science (quality and composition of clay, humidity and plasticity of clay, ceramic engineering), and (b) relations between ancient Greek art and modern science (vase decoration, mineral pigments, light and color).

For each of the two fields it is possible to organize educational activities-problems that lead to the building of the conceptual and cultural dimension of NST knowledge. For example, in the first field questions can be asked about the nature and physical properties of the clay, the physical changing during the baking of the object and in general in its mixing, forming, drying etc (conceptual dimension NST knowledge) and / or questions related to the historical, social and technological conditions of ceramic engineering development (cultural dimension of NST Knowledge).

From the pedagogical point of view, the structure we described gives the student the opportunity to evolve from a scientific and technological point of view, building a different view of science and technology, as well as their relationship with society, and being able to express and position themselves in front of various issues with responsibility and autonomy.

The infrastructure (design of the movable structure, laboratory equipment, various educative tools, etc.) is under development.

V. EPILOGUE

In this paper we tried to show that it is in principle theoretically and methodologically possible to design interdisciplinary museographic structures – educative islets - within the archaeological museum which will give to the targeted audience the opportunity to connect the dominant interpretation of the museum with the contemporary scientific knowledge. Future work should include, in addition to enhancing the epistemological validity and methodological reliability of the design of an educational islet, the investigation of the didactical effectiveness of such an endeavor. To do this, we need to design specific types of educational islets and investigate their cognitive and emotional impact on the target audience using appropriate evaluation tools. Financial resources and capabilities, territorial constraints, regions interventions in the already formed museum environment determine the materiality and its feasibility.

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COMIC TIMELINE: Heritage Comic Hub

An inspired cultural network based on creativity via cultural heritage

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***Abstract*— The whole action is based on the philosophy of open access, in the need to develop synergies and partnerships with other cultural communities, to create a local cultural network, to integrate with education, to create a holistic approximation, a cultural entertainment focusing on student's creative expression.**

This paper aims to present our one year museum educational project entitled "COMIC TIMELINE: A Heritage Comic Hub" and to outline the importance of creating an educational program based on new approaches and methods, on building synergies and nets with museum and school community, local communities and artists bearing in mind the needs, desires of our target group. Furthermore, it is about transforming a museum into a Heritage Comic Hub with the participation of different kind of experts related to our project and about reforming museum into an intellectual, pleasant and creative interactive cell.

The cooperating bodies such as the Archaeological Museum of Patras, the Department of Cultural Education of Achaia, MITOS, Comicdom Library, Cliomuse and comic artists had formed an annual connective art net, a local cultural network of this annual project that ended with an educational exhibition held for the Celebration of ICOM's International Museum Day 2016: Museums and Cultural Landscapes at The Archaeological Museum of Patras.

Museum used to be isolated space but nowadays its whole philosophy has been redefined. In the museum of the 21st century, the exhibits are part of the visitor's experience that act as a strong attraction and engagement tool for all students.

Index Terms *Heritage Comic Hub, learning museum, timeline, creativity, synergy, cultural network, exhibition*

I. INTRODUCTION

Museums are changing. The new mission of the museum is to use its collections as a tool of knowledge, inspiration and enjoyment. It aims to cause an interactive dialogue with all aspects of life, the past, the present, and the future of the world and its inhabitants. A new holistic museum educational strategy is being shaped, addressing issues such as: interpreting value, learning, creativeness, authenticity, inclusivity, interaction.

A big question arises among professionals of our field: "How can the museum meet the new trends and the increasing expectations of visitors such as students aged from 7 to 11 years old? How can it disengage from an isolated space and modernize its strategy by designing alternative programs that encourage the participation and creativeness?

The importance of creating an educational program based on new approaches.

Heritage Comic Hub (HCH) is focused on this new philosophy, HCH is about reforming museum into an intellectual, pleasant and creative interactive cell.

According to the three levels of public involvement/ recruitment [1, p. 23] the museum should adopt new trends of leisure, create the proper state of mind to students, so that they would want to actively engage with the collections and exhibits, and ensure the motivation and support of active participation.

Culture, and by extension the museum, can and must become a key factor for social inclusion, social cohesion, the harmonious coexistence in this difficult historic period for the global communities, an institution that can teach cultural diversity and democracy.

HCH is a museum educational net project based on the philosophy that a museum needs to be inspired by its collection and be connected to the city and to all education departments. Museum now opens up and develops links to the art creators in the city; it creates a permanent network of collaborations and partnerships local organizations, students, cultural groups, artists in the city. The

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cooperating bodies formed a permanent connective art net, a large local cultural network of this annual activity.
Museums, like all places where culture is exposed, should have an interactive character. Their role is to help their audience to understand, to learn and be part of high values. Museums currently have to offer different presentation perspectives and a variety of subjects in order to meet the needs of students aged between 8 and 11 and encourage their active participation.

Fig. 1. Comic Heritage Hub @Archaeological Museum of Patras. The story telling of Mycenaean Soldier

II. EDUCATION AND MUSEUM

The museums according to the definition of the British Museums Association give people the opportunity to discover their collections, and draw inspiration, knowledge and pleasure. They are institutions that collect, preserve and make accessible objects for the benefit of society. The museum is not an isolated place but an open source of collective memory, knowledge, inspiration and spiritual liberation [3, p. 4], a place in which one can gain understanding of the world, its collective identity and cultural diversity, its solidarity and cohesion, at national and international level [4].
Surveys of visitors have long shown the necessity of remodelling interpretation [5] [6], educational [4] and social approach[8] of the museum collections. Its main objective is to be reformed into an intellectual, pleasant and social interactive cell.

According to Black [1] the engaging museum focuses on:

- The involvement of the public;
- Bonding with the school community, families and local communities; The strengthening of intellectual, social and cultural access to exhibitions, collections, sites and services;
- The strategy to increase its audience;
- Easy public access to it and to its collections;
- Sense of public participation and developing ties with the museum;
- Lifelong learning;
- Improved quality of service to the visitor;
- Partnerships with communities, educational institutions, volunteers, local organizations, enterprises;
- The aesthetic and emotional pleasure, learning, entertainment, socializing.

Most successful museums offer a variety of experiences, which attract different audiences and reflect the diverse needs of every student, citizen, offer multiple experiences: aesthetic and emotional pleasure, learning, entertainment, sociability [9].

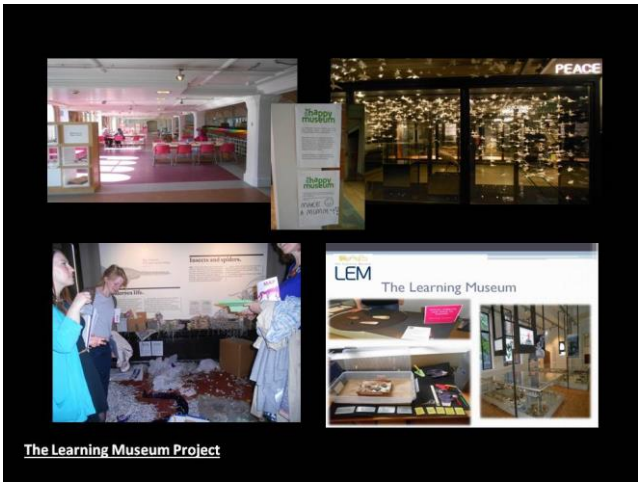

Fig. 2. Educational programs at Manchester Museum during the Learning Museum Project (LEM)

One of the authors [11], had participated in *The Learning Museum Project* (LEM) mobility and working group, at Manchester University Museum, investigating *New Trends in Museums on the 21st Century*.[1]

Several innovative museum practices to cooperating with education & communities, on museum development policy, as well as approaches to the holistic interpretation of collections with a series of exhibitions, events and programs for students of all ages, were addressed within this European Project. The Manchester University Museum implements educational programs and art walks in cooperation with other culture organizations of the city, like the Whitworth Gallery, the John Rylands University Library and also the Manchester Art Gallery.

The requirement was to engage the public [12] through more temporary exhibitions and cultural activities; the use of volunteers; and the hugely increasing significance of digital media and social networking was the main topic of the working group. The results were publicized in the LEM website.

The theme New Trends in Museums of the 21st Century turns out to be timely due to the need to navigate a path through the current crises and face challenges that are the outcome of a world-wide economic downturn. We have to identify emergent trends in museums at a time of rapidly changing circumstances, so as to assist museums to develop their future strategy towards to education.

[1] With a Grundtvig scholarship from the State Scholarship Foundation (SSF).

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Bearing in mind that new characteristics have to be defined when developing museum programs for the near future, the relationship between museums and educational and urban context is reconsidered, with the emerging notion of what we can call the 'expanded museum' [14]. In this context, museums have a new and important role as a hub for heritage and focusing increasingly on the intergenerational dialogue in a society. Museums are changing, the world is changing, societies are changing. Museums need to quickly adjust to their new role.

III. HERITAGE COMIC HUB

Comic and Education

In recent years, at a global level, a strong dialogue is taking place on Education system. How crucial is it today, the review and development of new policies in education? "School kills creativity". Truth or lie? Or the answer is probably somewhere in the middle.

We want children to be able to chase independent knowledge, whether these are provided in the school environment in a museum or anywhere else. Education should provide them with enthusiasm for knowledge. Education should create minds and thoughtful citizens who perceive knowledge as a tool to ensure a better quality of life. Education should held programs that will meet the expectations of young people.

Comics, according to many theorists, but also teachers, only tell stories of creatures with supernatural powers, but they have the supernatural power itself to transfer knowledge [14]. Their relationship with the educational environment began in the 1940s. In particular, according to a survey of the time, 95% of children aged 8-14 and 65% of 15-18 years of age were reading comics. This has not gone unnoticed by the academic community, with a view to launching a dialogue on the educational role of comics[2]. From that time onwards, comics invade School and university classes and the impact is so great that the Journal of Educational Sociology dedicates the entire volume of that year on this issue.

The whole project took into consideration the drawing development related to chronological age and stages. More specific according to our survey at the Schematic stage about 6-7 years old drawings are usually stable and fixed unless special factors motivate the child toward something else. At this stage they are not able to draw a model. They hardly look at it and seem much more influenced by their inner concepts of the objects than by their perception of them.

[2] Professor of the University of Pittsburgh, W.W. D. Sones, states that from 1935 to 1944 "the Comics featured in over 100 critical articles in education periodically".

Fig.3. Pottery and Colors entitled on of our educational programs@Archaeological Museum of Patras

During the next stage their ability to observe improves greatly. By observation is meant not only the act of seeing, but also an analysis of the observations which breaks down the visual impressions. By the age of 11 children begin to be aware of the necessity of active observation and to practice it more or less consciously.

In relation to sex differences Cohen, Money and Uhlenhuth [16] in a study of 385 children, 6-13 years old, found a tendency for the older children to draw themselves taller than the younger children. They also found that girls tended to draw themselves taller than the boys did. They hypothesized that this might be a reflection of the girls' earlier growth and maturation compared to the boys.

In another study by Weider and Noller (studied sex differences regarding to the drawing of profile figures versus figures seen from the front. In their first study of 10-year- old children, they found that half of the boys drew full-faced figures, while the other half drew profiles regardless of the sex of the drawn figure. Considering data on activity, girls at age 10 make the female figure more static while boys make them more active.

However, people vary in attention given to their own body and to their surroundings, they vary in their receptivity to visual and to internal bodily stimuli, and they vary in the specific symbolic meanings attached to various body parts. This means that different drawings will reflect the drawer's perception of the outer world and of his inner world in quite varying degrees.

To sum up the material produced by our network from our students after listening to certain stories were outstanding and beyond our expectations. Our stages of our project were formed as above.

1st Stage

Teacher Training

The participating teachers had a 10-hour seminar training by specialists, archaeologists, museum educators, comic-writers about the cognitive background and the methodology of

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implementing the project at the Auditorium of Patras Archaeological Museum. The participants had the opportunity to meet comics as an educational tool and its ability to motivate students. "Comics are visual, permanent, and intermediary. Comics are simple and have fun. You only need fantasy!"

2nd Stage

One day at the Museum!

An all day educational program at the Archaeological Museum with a small group of students. Introduction to the main map of the Museum at the entrance (place, timeline, conditions, what to follow, sense of intimacy with the space and confidence building, viewing the rooms from the bridge, viewing material).

An educational program held from the museum team with the cooperation of artists of the city. Selected exhibits/artworks from all three exhibitions were presented to the students through storytelling about their former use in everyday life during antiquity. The young students learned and were inspired by the selected exhibits of the Mycenaean and Roman period in order to create their own small comic stories with their own protagonists in a two (2) hour workshop held by the artist of our Archaeological Museum and the whole team.

3nd Stage

The COMICDOM workshop

Students were enlightened in the by the COMICDOM team, by specialized comics writers, cartoonists and designed the heroes of the comic stories in order to give life to their images. Students were assisted throughout their creation process all the year by the COMICDOM team and were guided also to produce animated films. A related educational visit was also organized in the unique Comic Book Library in Athens, where relevant educational programs were being implemented.

4nd Stage

Our Exhibition

The cooperating bodies such as the Archaeological Museum of Patras, the Department of Cultural Education of Achaia, MITOS, Comicdom Library, Cliomuse[3] and comic artists had formed an annual connective art net, a local cultural network of this annual project that ended with an educational exhibition held for the Celebration of ICOM's International Museum Day 2016: Museums and Cultural Landscapes at The Archaeological Museum of Patras.

Fig. 4 Our Comic Heritage Exhibition @ museum

The whole aim of this project *Heritage Comic Hub* was to build a strong communication and creative bond between the museum and students communities, stimulate participation and interaction with them, based on our cognitive tool Comic and entertainment. The huge challenge that museum had to face is to transform into a living creative cell, an alternative Comic Hub inspired by its exhibits and its artifacts assisting the development of society. The enhancement of cultural heritage through the museum, now more than ever, needs to offer a holistic yet humanitarian vision. A vision that can be a model of development centered on the human and on the solidarity in societies, through periods of crisis (economic, environmental, social, migratory, etc.). A new 'social-educational contract' is what we envision that new museology should be based on.

Fig.5. Students reading comics @ our museum.
An educational exhibition based on our cultural net/HCH.

The whole action is based on the philosophy of open access, in the need to develop synergies and partnerships with other cultural communities, with departments of education in order to create a local cultural network, to integrate with the city, to create a holistic approximation, a cultural entertainment focusing in human expression.

The Museum, the exhibits of our Culture Heritage is in the centre of this approach of, an approach of 'disruption' of the traditional museum collections with creative hubs, contemporary art installations, interventions and subversive formations in order to chat, and foster the interaction between different 'places' [15]. A heterogeneous aspect of the museum as a performance creative space with multiple and different meanings between objects/exhibits, words and drawing and the possibility of a special dialogue between traditional and contemporary artistic expression in the historical sphere is what underlies this proposed museum project.

[3] <https://cliomuseapp.com/>.

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Fig. 6. *Our educational exhibition HERITAGE COMIC HUB held for the Celebration of ICOM's International Museum Day 2016: Museums and Cultural Landscapes @The Archaeological Museum of Patras.*

Comic, as a fantastic dimension of museums through our storytelling, quickly became understood and perceived by most students of the project and this practice should be transferred to all museum professionals of education field. The educational, social, spiritual and emotional dimension of an alternative museum visit would be achieved by activating the imagination of the visitor via the event's editor, so as to create a certain atmosphere [13]. An initial script in the appropriate direction needs to be created first to spark their interest [29].

Fig.7 "Once upon in time in myceaneum period" a Comic Book created from students during our Comic Heritage Hub@museum.

CONCLUSION

The annual synergy described above highlighted once more the crucial need of cooperation among cultural and educational organisations in order to promote new methodological approaches, to attract young public and even evolve in terms of professional development. From our project came out an educated core of professionals that are going to expand our network, an innovative educational material based on comics and a series of good practices which we intend to communicate.

Nowadays we need to design new projects in museums at a time of rapidly changing circumstances, so as to assist museums to develop their future strategy towards to education. Bearing in mind that new characteristics have to be defined when developing museum programs for the near future, the relationship between museums and educational and urban context is reconsidered, with the emerging notion of what we can call the 'expanded museum'.

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Use of digital resources in Primary School cultural and heritage education. The DICHE menu

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***Abstract*—The present paper describes one of the activities foreseen by the Erasmus+ KA2 DICHE project (Digital Innovation in Cultural and Heritage Education in the light of 21st century learning). The aim of the project is to integrate digital resources and opportunities for cultural and heritage education in primary school. Content and structure of the workshop have been elaborated by the DICHE research group. The main objective of the workshop is to instruct participants in the use of the DICHE MENU, an online database of teaching scenarios for cultural and heritage education, which involve the use of digital resources in the development of the 4C skills (Creativity, Communication, Collaboration, Critical Thinking). The two main pillars of the DICHE workshop, "use of digital resources" and "heritage education", are in line with the most recent national and international field literature research and with the latest Italian education system directions, aiming at a more aware use of technology, in order to develop pivotal skills in active citizenship building.**

Index Terms *digital resources, museum education, technology, HEI, critical thinking.*

I. INTRODUCTION

For several years, the Laboratory for Educational Research (LPS) at the Department of Education of University Roma Tre has been developing a research line aimed at promoting a critical use of technology, which could help the twofold objective of interpreting technology as a tool and increasing critical thinking skills.

These research activities allowed the LPS, and its Centre for Museum Studies branch (CDM), to submit an Erasmus+ project, called Digital Innovation in Cultural and Heritage Education in the light of 21st century learning (DICHE), which was funded in September 2015.

The project, 30 months long, involves six partners from four European countries: Netherlands, Belgium, Great Britain and Italy. The main purpose of the DICHE project is to integrate the use of digital resources in the primary school learning processes, especially concerning artistic and cultural heritage education.

The DICHE project has the following priorities:

1. Enhancing digital integration in learning, teaching, training and youth work at various levels.
2. Developing basic and transversal skills using innovative methods.
3. Strengthening the profile of teaching professions.

Enhancing digital integration in learning, teaching, training and youth work at various levels

By developing a research agenda, university professors and teachers are provided with a theoretical framework for the use of digital tools in education, especially in cultural and heritage education. Moreover, the agenda can be the basis for new academic research, yielding new insights into the use of digital resources in education. Moreover, by developing and disseminating a menu of teaching scenarios for cultural and heritage education, which involves the use of digital resources, (prospective) teachers gain access to a set of practical scenarios that they can immediately use in class. In other ways, by making the set of scenarios available to prospective teachers and other teachers, the project enables digital integration in learning and teaching at primary schools.

Developing basic and transversal skills using innovative methods

The aim of integrating digital resources and opportunities in education (especially in the field of cultural and heritage education) has to be seen in the light of 21st century learning. In their work titled "21st Century Skills: Learning for Life in Our Times" [1], Trilling & Fadel create a framework of transversal skills necessary to prepare society for the complex realities of the 21st century. Critical thinking, Creativity, Communication and Collaboration – the 4 C's – are incorporated in the menu. The scenarios allow children to reflect critically on cultural and heritage issues and to collaborate and communicate in groups in order to come up with creative solutions to the posed problems. In addition to transversal skills, through different assignments that are part of the scenarios, teaching objectives also pay attention to basic skills such as writing and mathematics.

Strengthening the profile of teaching professions

As part of the project, prospective teachers are educated about the use of teaching scenarios that involve widely available digital resources. Moreover, the aim is to implement the courses in the regular curriculum of prospective university professors (mostly after the project). Additionally, through dissemination, teaching scenarios become available for other teachers in the EU. By instructing teachers on when and how to use digital resources in their teaching (additional output of this project), the teacher profile is strengthened.

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Such objectives are in line with the European Union directions regarding the need to integrate the current learning systems with new methods and technological tools, in view of the development of active citizenship skills. The development of the pupil's abilities at school re-calls the Recommendation 2006/962/EC of the European Parliament and Council, 18th of December 2006, on key competences for lifelong learning [2]. In the recommendation, competences are defined as a combination of knowledge, abilities and attitudes suitable to the context, necessary for realization and personal development, active citizenship, social inclusion and employment.

II. THE DICHE PROJECT

The application of digital resources in the field of artistic and cultural heritage education is a real challenge for innovation: museum education, interested since several years in research made in this field, has the opportunity to broaden the areas of integration of technologies and, at the same time, developing new teaching methods for younger users. The development of this project foresees the dissemination of an effective teaching methodology, designed in the academic field, among primary school teachers, allowing a better knowledge and preparation for future and current teachers, and also to evaluate immediately possible impact in the teaching context, as well as in the learning one. The LPS/CDM research group, in particular, is involved in spreading the use of digital tools in innovative museum teaching contexts both in the academic field and in training university education students and future teachers, adopting the theoretical and practical foundations of the DICHE project.

In recent years, the issue related to the ways new technologies can help knowledge spread to become more open and free has been brought to the attention of educators and administrators communities all over the world. New technologies have been introduced in school education: in Italy, the National Digital School Plan (started in 2008 and transformed in one of the pillars constituting the 107/2015 act, aiming at creating new learning environments) promotes experimentation of new models, the use of innovative tools, the dissemination of best practices, the project of school curricula to turn the rule "class at the laboratory" upside down and get "more laboratories in class" [3]. Besides enriching schools with technological tools, it is mandatory to train prospective teachers and educators in the use of innovation and didactics design and in the use of integrated digital contents (CDI – L. 221/2012), Learning Objects, LIM and OERs.

In the National guidelines for Pre-primary and Primary school curriculum [4], the relevance of art and cultural heritage study is stated as pivotal from pre-primary school, as experience field able to stimulate and address pupils towards more and more well sounded learning: "children meeting art is their chance to look at the world differently. Multi-sensorial exploration of materials, experimented and shared techniques within school ateliers, on site (squares, gardens and landscapes) and work of arts (pictures, museums, architectures) observations help perception, fruition, production and invention skills and to make culture and heritage closer" [4].

Starting from the above assumptions, the LPS/CDM research group designed a dedicated workshop addressed to museum operators, prospective teachers, and educational sciences students in general to develop prospective educators skills in the fields of cultural and heritage research and class activities implementation, specially addressed to primary school children.

III. METHODOLOGY

The workshop "Digital Innovation in Cultural and Heritage Education" has the following objectives:

- to present the DICHE menu of digital tools and set of recommendations in the promotion of digital resources in Primary School through cultural and heritage education;
- to invite participants to reflect upon the possibilities for digital integration and innovation in their own museum and cultural educational and research activities;
- to instruct participants on how to use the DICHE menu of digital tools themselves;
- to guarantee full access to the intellectual outputs of the DICHE project by presenting the online locations on the project partners' websites where they can be accessed.

The DICHE menu is a set of teaching scenarios that promote the use of digital resources and innovative learning method in cultural and heritage education, with the aim to develop transversal skills. By developing and disseminating a menu of teaching scenarios for cultural and heritage education, which involve the use of digital resources, (prospective) teachers, educators and researchers gain access to a set of practical scenarios that they can immediately use in class and in their researcher activities. Integrating the necessary skills to deal with complex 21st century realities in primary school education, such as the 4Cs Critical thinking, Creativity, Communication and Collaboration, asks for innovation. Cultural and heritage education has the potential of integrating 21st century learning in education, whereas digital resources can make cultural and heritage education more appealing to pupils. However, schools and cultural educators struggle to use the full potential of digital learning tools. They invest in digital equipment such as smart boards and tablets, but often use it rather conservatively. Meanwhile, developers of ICT/digital storytelling tools in education aim to make the existing technologies more mainstream in education. Scholars in (digital) innovation in (cultural and heritage) education still face many pending research questions related to the effects of using digital tools and resources in education.

To address the needs of primary schools, teachers, teacher's colleges, parties active in culture and heritage, the ICT/E-learning sector and scholars, this project aims to integrate digital resources and opportunities in primary education in general and in cultural and heritage education in particular. Thus, the workshop supports participants to deliver high quality teaching, to deal with complex classroom realities and to adopt new teaching methods and digital tools

The workshop is composed by 3 main sessions:

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1. The DICHE menu. How integrate digital tools in cultural and heritage education?
2. *I see, I think, I wonder*. Open discussion on innovative learning methods for developing transversal skills in cultural and heritage education.
3. *And now it's your turn*! Teaching scenarios design through the DICHE menu database.

The first session (30 minutes) has the aim to present the DICHE menu to participants, its structure, its use in classroom and in research activities. The menu will be presented in an interactive way, through the BYOD method and the MUSETECH Web App. Also, the DICHE project theoretical framework is presented and discussed.

The second session (30 minutes) aim is to invite participants to discuss about the following themes: the use of digital tools and innovative learning methods in cultural and heritage education; the promotion of 21st century skills through digital tools; primary school and digital resources: advantages and disadvantages. The session is presented and carried on with the use of digital resources, in order to open the discussion also through social media (Twitter) and online tools (Padlet).

The third session (30 minutes) is completely dedicated to the designing of innovative learning pathways in cultural and heritage education for Primary School students. Participants, divided in group from 3 to 5, use the DICHE menu with their devices and create a learning activities starting from the DICHE teaching scenarios, adapting it in different context and setting. At the end of the session, all teaching activities created will be shared and discussed also through social channels (Twitter). Presenters will help and stimulate the creation of the learning pathways during the session.

IV. THE DICHE MUSETECH WEB APP

The Musetech name is a combination of two words: "Museum" and "Technology". Both of these two concepts play a crucial role in reaching DICHE project main aims and goals. The idea at the basis of the app was to introduce the social dimension into the DICHE project, involving final users in order to reach a wider audience, through the use of major social networks, creating a network of researches, teachers, students and general final users interested into DICHE tools and practices. Like other famous Web App and services in the Internet, the MuseTech Web App allows users to vote through a five-star rating system any of the tools and practices collected inside the DICHE menu. Furthermore, it boosts communication between users allowing them to share a tool or a practice that they found of particular interest on their preferred social network.

Musetech Web App does not require any registration to browse tools or practices and it allows to conduct an advanced search through the whole catalogue thanks to filters and categories as in the DICHE menu. Nevertheless, it requires a social account (Facebook, Twitter or Google) in order to access the social sharing, commenting and voting functionalities. To enhance the collaboration dimension, we developed the Musetech App like a social place where it is possible to share thoughts, questions, ideas and solutions into the dedicated comment section present at the end of each tool or practice. Furthermore, the Musetech App allows users to "follow" a thread of comments for a specific tool or practices, receiving a notification by email once new comments are added for that particular tool or practice.

Why a Web App? For the DICHE project we decided to develop a web app application since it is not developed specifically only for one particular mobile device and it does not require any direct installation onto the device itself. It is basically an internet-enabled app that is accessible via the mobile device's Web browser and which does not need to be downloaded onto the user's mobile device in order to be accessed.

The Musetech Web App is available for free at the following address: http://www.musetech.it/.

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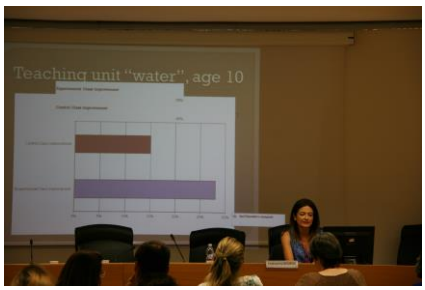

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