CO-DESIGNING MUSEUM ITINERARIES IN A STEAM PERSPECTIVE FOR KINDERGARTEN AND PRIMARY SCHOOL CHILDREN: AN EXPERIENCE AT MICROMEGAMONDO IN PADOVA

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Abstract

This action-research project, launched in 2023 and still ongoing, aims to devise and implement museum education experiences specifically for kindergarten and primary school pupils by combining the skills of a group of professionals collaborating on this initiative.

In detail, the following participants have been annually involved:

- Two hundred and fifty pre-service teachers attending the last year of the single cycle degree course in Primary Education Sciences at the University of Padova. They are about to start working as teachers, or in some cases, they are already active in schools while attending the course.
- Seven Biology Lab tutors, including headmasters and teachers, with experience in kindergarten or primary school. Their expertise supports pre-service teachers in elaborating STEAM immersive experiences and becoming "Nature-familiar adults".
- Two Biology professors in Primary Education Sciences course at the University of Padova; they provide pre-service teachers with disciplinary and methodological skills needed to train effective teachers in STEM;
- The scientific director and guide coordinator of Esapolis Museum in Padova: it is the largest insectarium in Europe and one of the major environmental education centers. It houses both important historical artifacts related to arthropods and a lot of living invertebrates.

In these two years of partnership, many original museum itineraries have been elaborated as new stimuli in the STEAM perspective; they have been realized partly in the museum and partly in the schools where the protagonists operate.

These experiences have been tested in the museum with kindergarten or primary school visitors and their accompaniers. The aim is to assess the activities effectiveness, especially in terms of their ability to wonder, embracing Carson's assumption: "if a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and mystery of the world we live in".

After a testing phase, some of these experiences have been opened up to teachers and young visitors' parents to create connections and interdependence between the formal, non-formal, and informal systems. In this way, many opportunities that authentic contexts can offer are synergistically used in a sort of "decentralized classroom", in Frabboni's acceptation.

Keywords: didactics of Biology, arthropods, laboratory activities, learning by doing, museum teaching.

1 INTRODUCTION

Esapolis, the Living Museum of MICROMEGAMONDO, was founded in 2008. This first Italian large insectarium is the result of a fruitful collaboration between the Province of Padova, the social promotion association "Kheprica" and "Butterfly Arc", a non-profit environmental organization focused on education, research and biodiversity conservation, that opened in 1988 the first Butterfly House in

Montegrotto Terme. Since then, Butterfly Arc has been hosting about 100 species of tropical butterflies in all stages of development, which live freely among the lush rainforest plants in an environment that perfectly reproduces the climate, allowing visitors to live an immersive experience in such a particular endangered biome.

It (Fig. 1A) is located in the site, dating back to the late 1800s, of one of the world's most important bacological stations, which is still active today as an assistance, conservation and research organization of the Ministry of Agriculture and Forestry.

The museum houses a huge amount of historical collections of instruments, tools, books, valuable entomological boxes and silkworm cocoons from all over the world (Fig. 1B).

There are also living exhibits of insects, arachnids, reptiles, amphibians, fish and many other small creatures that constitute the largest animal biomass on our planet (Fig. 1C).

A B C

Figure 1. Esapolis, Museum of the MicroMegaWorld in Padova.
In succession: A. The exterior of Esapolis. B. An example of the historical collections.
C. An example of living animals in cases.

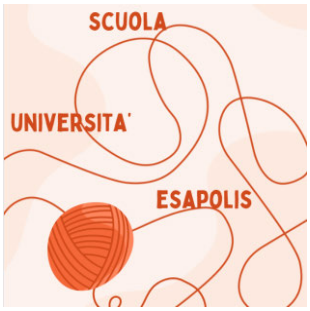

Figure 2. Project logo.

Esapolis is also an important resource for education and research in the field of entomology; it is committed to stimulate a culture of sustainability and the protection of biodiversity in accordance with the principles expressed in the 1992 United Nations Conference in Rio [1].

The converging interests of sharing and increasing the opportunity of museum teaching as a chance for active Science teaching/learning in preschool and elementary school, led Esapolis and the University of Padova and its course degree in Primary Education Sciences, to signing an agreement in 2023. This agreement resulted in a project, which is still ongoing, aimed at devising, implementing and evaluating museum didactic experiences for the age group under study, carried out by a pool of professionals that constitute the project team. The common intention is consolidating and renewing the dialogue between the museum and school reality, in order to build an educational continuum as represented in the project logo (Fig. 2).

2 METHODOLOGY

To achieve a fruitful dialogue between school and museum, sharing the methodological scenario within which both operate, was needed.

On the one hand, the 2012 Italian National Indications mention some principles that characterize effective educational actions by the school institution:

- "Encouraging exploration and discovery to promote the pleasure of searching for new knowledge. In this perspective, problematization plays an irreplaceable function: it urges pupils to identify problems, to raise questions, to question already developed knowledge, to find appropriate inquiry paths, to seek original solutions";
- "Carrying out teaching activities in laboratorial form to encourage operability and, at the same time, dialogue and reflection on what is done. The laboratory [...] is the format that best encourages research and planning, it engages pupils in thinking, realizing, evaluating activities experienced in a shared and participatory way with others, and it can be activated in different spaces and occasions inside the school and by enhancing the territory as a resource for learning" [2].

Such principles are reflected also in the Guidelines for STEM subjects, which suggest:

- Teaching through experience, as long as "the natural, artificial and social living environments in which pupils are immersed are permeated with mathematical, scientific and technological concepts that can be explored through direct and concrete experiences. Such experiences allow the examination of different aspects of reality or problems, the emerging of questions and hypotheses, the active search for a plurality of possible answers and solutions, comparison, verification, the rising of new questions or new developments. Organizing activities that actively involve pupils also promotes the development of practical skills";
- Adopting laboratory activities, as long as "the laboratory, considered both as a physical place and as a time when the student is active, becomes a fundamental element, because it allows her/him to formulate hypotheses, test them and check their consequences through the collection of data and evidence, to debate her/his choices, negotiate conclusions and be open to the construction of new knowledge. The laboratory enables the selection and implementation of experiments that allow the exploration of phenomena with a scientific approach. Experimentation, investigation, reflection, contextualization of experience, use of discussion and argumentation, carried out at both individual and group levels, strengthen pupils' confidence in their own thinking skills, learning from their own and others' mistakes, and being open to opinions different from their own" [3].

Moreover, the European Commission promotes the evolution of the STEM idea into STEAM (where A identifies the Arts and, consequently, the humanistic disciplines), "a multidisciplinary set of approaches to education that removes traditional barriers between subjects and disciplines to link STEM and ICT (information and communication technology) education with the Arts, Humanities and Social Sciences" [4].

On the other hand, Esapolis museum has also introduced diversified ways and languages to increasingly connect with visitors, orienting its action from "collection centered" to "visitor centered" over time [5,6]. In other words, each visitor is not only able to hear and see what Esapolis offers, but she/he is also placed in the conditions of all-round sensory and workshop experiences characterized by Dewey's "learning by doing" [7]. The museum becomes an authentic learning environment [8] consistent with the definition of museum elaborated in Prague in 2022 by the International Council of Museums, an advisory body of the United Nations: "a museum is a permanent non-profit institution serving society, which researches, collects, preserves, interprets and exhibits tangible and intangible heritage. It [...] promotes diversity and sustainability. It operates and communicates [...] with community participation, offering different experiences for education, pleasure, reflection and knowledge sharing" [9].

Therefore, school and museum cannot avoid dialoguing in order to synergistically use the opportunities that authentic contexts can offer in a kind of "decentralized classroom" as defined by Frabboni [10]. Frabboni also highlights the need to experiment forms of linkage and interdependence between the formal system (the school), the non-formal system and the informal system.

This mutual support is recalled by the Council Recommendation on the validation of non-formal and informal learning in 2012. This document corroborates the essential role of knowledge, skills and competencies acquired through non-formal and informal learning in increasing motivation for lifelong learning. Non-formal learning is delivered through planned activities in terms of learning aims, time and forms of learning support (e.g., student-teacher relationship); it may include programs for the attainment of vocational skills, adult literacy and basic education for early school leavers; a typical example of non-formal learning is job training. Informal learning "results from daily life activities related to work, family or leisure time; it doesn't provide structures in terms of learning objectives, time or resources; it may be unintentional from the learner's perspective" [11].

The Primary Education Sciences course at the University of Padova adopts a teaching approach to Biology based on arousing emotion and amazement in students while studying living organisms. It focuses on active and collaborative experiences starting with the garden or schoolyard, which are the closest outdoor environmental contexts of learners [12-42]. In this perspective, educational practices involve emotional, affective and value aspects, facilitating the individual cultural rootedness with each learner's natural context, aligned with the principles of eco-pedagogy [43-55]. Once the value of the physical and relational environment has been internalized, thanks to a process of empathic transfer, students can assume similar behaviors toward the global environment and consequently modify their personal lifestyles [56]. Indeed, today's children are for us the first representatives of future generations, to whom the core idea of sustainable development is linked [57].

Moreover, the Primary Education Sciences course promotes the awareness that, from a STEAM perspective, each teacher can actively contribute to spreading the knowledge and operate the preservation of biodiversity through active teaching/learning, for example choosing laboratorial and learning-by-doing activities, as well as implementing meaningful integration between both the fields of experience in kindergarten and the subject domains in primary school.

Recognizing common intentions and sharing operating modalities, school, Esapolis Museum and University has been operating to set channels of communication and exchange of expertise, aware that they "do not operate in isolation, but are strongly interconnected and mutually reinforcing" as emphasized by the European Commission in the Reflection Paper Towards a Sustainable Europe by 2030 [58].

2.1 Participants

In order to profitably collaborate, various professionals have been involved in the project team, namely:

- Two hundred and fifty pre-service teachers, who attend the last year of the single cycle degree course in Primary Education Sciences. They are going to work as teachers, or in some cases they are already active in schools while attending the course. The opportunity to simultaneously play the role of both teacher and learner allows them to understand more easily the importance of elaborating, even in a museum, and engaging in age-appropriate activities for visitors. In addition, these experiences should be capable of fitting in a formative continuum with their school activities;
- Seven Biology Lab tutors, including school headmasters and teachers with experience in kindergarten or primary school. Their expertise supports pre-service teachers in elaborating STEAM immersive experiences and becoming "Nature-familiar adults" [59];
- Two Biology professors in Primary Education Sciences course at the University of Padova, who constantly provide pre-service teachers with disciplinary and methodological skills needed to train effective teachers in STEM;
- The scientific director and guides coordinator of Esapolis Museum in Padova.

2.2 Phases

The project is basically structured in six phases.

In the first phase, the project team members have shared the guidelines that support the entire project: STEAM approach, laboratory teaching based on the scientific method, learning by doing, educational dialogue between school and museum, and between formal, non-formal and informal learning.

During the second phase, about two hundred and fifty pre-service teachers attending the Biology Lab every year had the opportunity to visit Esapolis museum under the guidance of the scientific director, and then to plan groups activities that could be spent with pupils to promote knowledge and wonder in active, holistic ways both in schools, after the visit, and in the museum, as part of the experience.

Until now (the current academic year 2023/2024 is still ongoing), students have elaborated more than 50 teaching itineraries per year, involving living arthropods that can be bred indoor (e.g. stick insects, silkworms) or observed outdoor (bees, spiders) and focusing on different aspects of interest (e.g. nutrition, motion, communication, reproduction, protection, sleep…). These itineraries, planned for children of a specific age, consist mainly in concrete activities, such as games, dance, coding, music, dramatization, artifacts (e.g. creating bug hotels, 3D models…), drawings/paintings, short stories or poetry: the added value of students' proposals lies in their multidisciplinary nature and openness to the

concrete and experiential holistic approach, responding to the principle of unity (“eye, hand, head and heart”) of every young learner, considered in her/his ecological life context (Fig. 3).

Figure 3. Two examples of Biology Lab students’ ideas, for kindergarten and primary school.

In the third phase, the project team members have analyzed pre-service teachers’ learning activities, assessing their compliance with the project guidelines and their practical feasibility. The most original and effective ideas have been selected and, if needed, readjusted to be put in practice with the museum’s visitors (pupils attending kindergarten and primary school) by the museum guides during the fourth, testing phase.

Currently the fifth phase, consisting in the collection and analysis of feedback from young visitors, their teachers and/or accompanying adults, is still ongoing. The sixth and last phase consists in redesigning the process and reshaping the formative activities, for both University students and museum visitors.

3 RESULTS AND CONCLUSIONS

Even if the project is still in progress, the first outcomes have already been presented in May 2024 at the 5th University and School Conference, an event organized by the Primary Education Sciences course at the University of Padova aimed at stimulating and enhancing an active partnership between University, schools and local educational agencies. The project was considered one of best practices with respect to the topic covered, as the Conference entitled_ "STEM & STEAM: a holistic approach for a motivating education" summarizes its goals.

Positive results have emerged for each type of participant at the described project.

Two hundred and fifty pre-service teachers have experienced how Biology immersion can be set in schools, starting with indoor and outdoor activities while approaching a certain topic and stimulating learners to raise questions, shifting through museums to deepen knowledge, make complement experiences, use specific tools and alternative research methods, then coming back to schools to continue building knowledge through laboratory activities, and eventually letting experts to access the schools in order to enforce the osmosis between different form of knowledge and expertise into the learners’ daily setting (Fig. 4).

Figure 4. A formative continuum example: school and museum activities.

Additionally, they could directly establish a contact with resources available in their territory, capable of building their own toolbox and developing an attitude of lifelong learning for their professional career. Furthermore, this experience enabled them to realize that academic studies and school reality can work in synergy, proving the closeness between research and educational practice.

Seven Biology Lab tutors have provided pre-service students with “scientific experiences of wonder” to arouse amazement, which is an essential element of interest in learning. During the laboratory activities, each student perceived her/himself in peculiar ways: surprised, motivated, scared, disgusted, interested, fascinated, explorer, magnetized, touched… Such feelings depended on the stimula, on the learners, but also on the tutors, who contributed to increase student’s expertise and could spend it in their schools as pupils’ teachers.

Biology professors in the Primary Education Sciences course noticed a positive impact of the project, both for students and for the Athenaeum. With respect to students, they reported an increased attention/interest in Biology, considering the number of assigned thesis in the field; a boosting enthusiasm for "hidden life" from macroscopic to microscopic observation emerged by the increasing number of experiences in schools led by new in-service teachers; an impressive imaginative exercise with valuable original solutions was found in pre-service and in-service teachers to model complex concepts in an accessible way for the learners' age; a general awareness of the connection and interdependence between organisms was gained. With respect to the Athenaeum, the Professors appreciated the dialogue among the University and the educational agencies in the territory, that worked synergistically for the initial teacher training; within the field of the European 3rd mission, it is desirable that such formative relationship could continue over time, possibly involving the students who concluded their studies as well and planning residential meetings in natural settings for research and refreshment.

The scientific director of the Esapolis museum noticed some positive outcomes too. With respect to the students, he appreciated their own peculiar way of experiencing the museum even with their own fears; he thinks that students have developed skills to relate to living organisms (some of them are easily bred at school, even in an autonomous way), and they elaborated ideas to be developed in continuity with their museum experiences. With respect to the Athenaeum, the project in his opinion was a valuable opportunity for dialogue and discussion on museum teaching. Nevertheless, Esapolis has been currently collecting data and feedback by the young visitors, who have experienced the museum itineraries drawn by pre-service teachers during the Biology Lab, and their accompanying adults. The aim of this 5th phase in fact is to check the effectiveness of these itineraries, especially in terms of ability to generate interest and adopt Carson’s perspective: "if a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement and mystery of the world we live in [10]. Afterwards, some materials are going to be available to the children's carers, whether parents or teachers, to create connections and a positive interdependence between formal, non-formal and informal systems (Fig.5).

Figure 5. An example of material available to parents or teachers

In this way, it will be possible to gather synergistically the opportunities that authentic contexts can offer in a “decentralized classroom” [10].

To conclude, the Authors believe that such an amount of stimuli and mutual professional relationships could hopefully contribute to create a community of practice not confined to a single context, but sharable and able to build action-research experiences with respect to active Biology teaching and learning.

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