THE VIRTUAL MUSEUM OF STEM

User guide

CONTENTS

INTRODUCTION

What is this museum

This is an interactive virtual museum of STEM for secondary education, a fictional 3-dimensional construct borrowing its architecture from video games and virtual reality with virtual rooms containing collections. These collections are divided in four categories:

- the Science Exhibition,
- the Exhibition of Technological Advancements,
- the Contemporary Engineering Collections,
- the Exhibition of Hidden Mathematics.

These collections consist in virtual depiction of real items or phenomena in the 3D form with animations and static elements. The main goal of these collections is to be visual consistent and homogenic in order to provide an immersive experience of the virtual museum as a whole.

This museum allows a greater engagement from students in the school age helping shift the way that mathematics and science are perceived by them in the process. This museum can be used as a pedagogical tool by educators helping conjugate methods of formal and informal learning, within a context that fosters conditions of inspiration and creativity.

The whole museum is created with inclusion in mind, with accommodations for

students with Specific Learning Disorders (SLD) to facilitate the learning process making this virtual museum a method to supplement formal education without the potential anxiety students with SLD encounter in the formal learning context due to the learning difficulties.

Pedagogical interests

There is a significant and persistent underachievement in mathematics and science among students in secondary education in the European Union, therefore there is a need to rethink the way mathematics and science are thought in school because it is often seen as abstract, difficult, and disconnected from the daily life, hence the importance of increasing the learners' motivation and engagement in these subjects. For this reason, making STEM more concrete in secondary schools can be a solution for the motivation and engagement of the students.

Accessibility is an important aspect of this museum; therefore the conception of the user experience is tailored to students' different abilities and needs. Teachers understand that students do not learn all the same pace and often they do not react the same way to the same pedagogical material. In this museum, the student has control over the way they explore the content, being able to visit and explore at their own rhythm giving them agency over their education.

Teaching online became a new reality due to the COVID19 pandemic, even if classes and activities are going back to normal, there has been a change in the way that online teaching methods are explored to support in-class teaching blending online and offline methods.

Due to the COVID19 pandemic several museums have already adapted their website to accommodate people that cannot physically visit the museum but there are still barriers because several of them are not free. The VM STEM online museum provides images (3D and 2D), audio and video but also reliable information of objects and concepts that are often taught in class, it can be helpful to school programs just as any extra-curricular activity or field trip to a physical museum, this option can be more easily accessible to students because of the simplicity to access online, lack of time limit and gratuity.

Virtual environments offer an immersive experience making it an enjoyable learning activity for the students: “Virtual museums can serve as a tool for learning by entertainment, where learning takes place through active exploration, collaborating with virtual agents, or as an interaction with a virtual narrator that is humanlike and capable of communicating, while using the museum” (Daniela, L. 2020). Visitors can interact with the exhibitions and take their time with one specific collection rather than the other. The use of virtual museums does not require the supervision of a teacher, on the contrary, students can visit anytime and use it autonomously.

Virtual museums have the potential to offer an interdisciplinary and multilayer educational resource that can be helpful to expand student’s horizons and acquire autonomy in their learning activities and interests.

Virtual museums are helpful to tackle accessibility problems offering a mobile pedagogical tool that helps enhance smart pedagogical solutions while helping to strengthen information perception and, therefore, the memorization of information and the construction of knowledge (Daniela, L. 2020). Whilst virtual pedagogical solutions available today cannot replace human pedagogical aspects, they can act as a tool to enhance learning and “bring joy to learning

itself through experiencing physical phenomena in a mixed reality (MR) environment" (Daniela, L. 2020).

To make virtual museums a learning agent, it is important to blend the virtual aspect with the reality creating a mixed reality approach because both can be complementary to each other and satisfy the shortcomings of each other. The mixed reality approach brings an enjoyable aspect to learning that makes it more engaging and accessible to students in general.

According to Linda Daniela the author of the article "Virtual Museums as Learning Agents" virtual museums can serve as learning agents because it enhances analogue reality with digital information, it integrates information in a coordinated way, and it facilitates the combination of different resources such as texts, websites, video, audio and 3D (Daniela, L. 2020). The author also states that the use of virtual museums can help:

1) Explore learning from a perspective of motivation and cognition sensory development and the development of specific skills,
2) identify pedagogical gaps and assist in supplementing them,
3) help steer students through different sets of experiences and use the virtual museum as a learning agent,
4) to help teachers improve learning processes and help students become proficient users of technology but also creators of new technological solutions.

Learning environments have been changing drastically for the past 50 years due to technological and communications development (Spector, J.M. 2014) in addition, this change was accelerated due to the COVID19 pandemic, virtual learning environments are being more explored than ever, therefore virtual museums can be a motivating tool for both students and teachers to complement classroom learning within a defined and inclusive framework.

MUSEUM DESCRIPTION

Global description

This museum is an interactive virtual museum of STEM open to external users but mainly targeted at STEM teachers in secondary education, students, non-formal science communication organizations, to use in their own teaching activities. The museum is composed of four parts that the visitor can choose from, each part has either 20 or 10 collections: Science Exhibition (20 collections), Exhibition of Technological Advancement (10 collections), Contemporary Engineering Collection (10 collections) and Exhibition of Hidden Mathematics (20 collections).

Each collection contain:

- A main element either in 3D models or 2D models that are static or animated.
- One or several additional elements such as explanations in text, pictures with a reference, videos with subtitles and audio files.

The visitor can choose which part of the museum they want to explore, once in a selected part they can interact with the collections by exploring the main element and/or the additional elements. If the element is animated, the visitor can use a progression bar to move into the files and they can enable and disable subtitles.

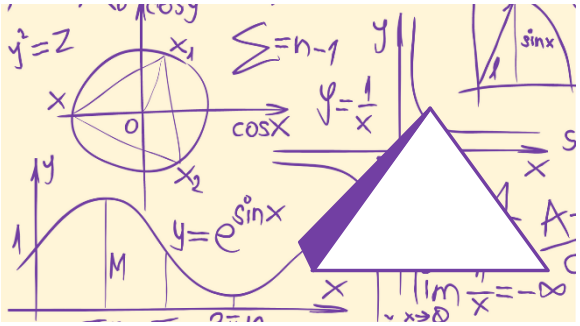
The global design of the museum is contrasted by colored and grey parts, the colored parts of the museum identify the collections while the grey areas identify where the visitors can move.

The museum is available in Croatian, English, French, Greek and Portuguese, the user can easily change the language and the museum is directly updated.

As keyboard are different in Europe, the user has the possibility of changing the movement keys in the museum in order to move forward, backward, to the right and to the left. These keys can easily be changed afterwards if it is necessary.

Collection example

Museum Part: Exhibition of Hidden Mathematics



Subject

Thales Theorem

Description

Thales theorem in the virtual museum is presented in a more practical and concrete manner instead of theorical. The main element consists in the calculation of the height of a pyramid by Thales. Additional elements are available to understand the context of his findings and a few examples to help solidify the concept.

Main element

The main element's name is "Pyramid's Height". It is an example of how Thales used his theorem to discover the height of a pyramid, the calculation of the height of a pyramid with the Thales theorem is exhibited with the help of a static 3D model that illustrates the method that Thales used to calculate the height of the pyramid using its shadow and the shadow of a stick that the height is known. This 3D model has a legend in the text explaining it and giving further information for context about the calculation and the image.

Additional elements - 1

This additional element is called “Who was Thales of Miletus?”, it gives context to Thales life and work through a small video with subtitles. The video explains his contribution to geometry and also to philosophy.

Additional elements - 2

This addition element is named “Theoretical explanations”, it gives a more theoretical explanation of the Thales theorem and how it works with a link to the main element. This additional element consists of texts and graphs to support the main element: the example of the pyramid.

Additional elements - 3

This additional element is named “The world at the time of Thales” it provides more information on the context where Thales made his discovery, it is exhibited mainly through images, text and/or sculpture. The era that Thales lived and its influences in his work is exposed in this part.

Additional elements - 4

This additional element consists of further examples and exercises. This element is a series of 5 concrete examples, each linked to a different domain, thus offering several angles through which the user can grasp the concept. It is divided in two parts, the first one with the unanswered exercises and the second one with the answers and explanations to the exercises.

To summarize:

As this example shows, the collections follow this structure. The whole museum is divided into four parts and each part will contain different collections, some parts having 10 and some parts having 20. Each collection contains a main element and additional elements to support the main one. These elements are presented in different formats such as text, image, and video. The structure is clear, intuitive and inclusive for easy access.

HOW TO NAVIGATE IN THE MUSEUM

Technical requirements

This museum can be accessed from any type of computer and from any browser (IE, Google Chrome, Safari, Firefox, etc.). It has been conceived to be intuitive and to allow an optimal user experience. The accent is on accessibility from a technical standpoint but also from a pedagogical perspective. Any person with a computer with access to the internet can connect to the museum.

Move into the museum

At the start of the museum, the visitor can see the slides of the project and partners logos and the EU disclaimer for a duration of four seconds, but the visitor is able to skip this part by clicking on the skip button on the bottom right corner of the screen.

Created by the following organizations:

CITIZENS IN POWER

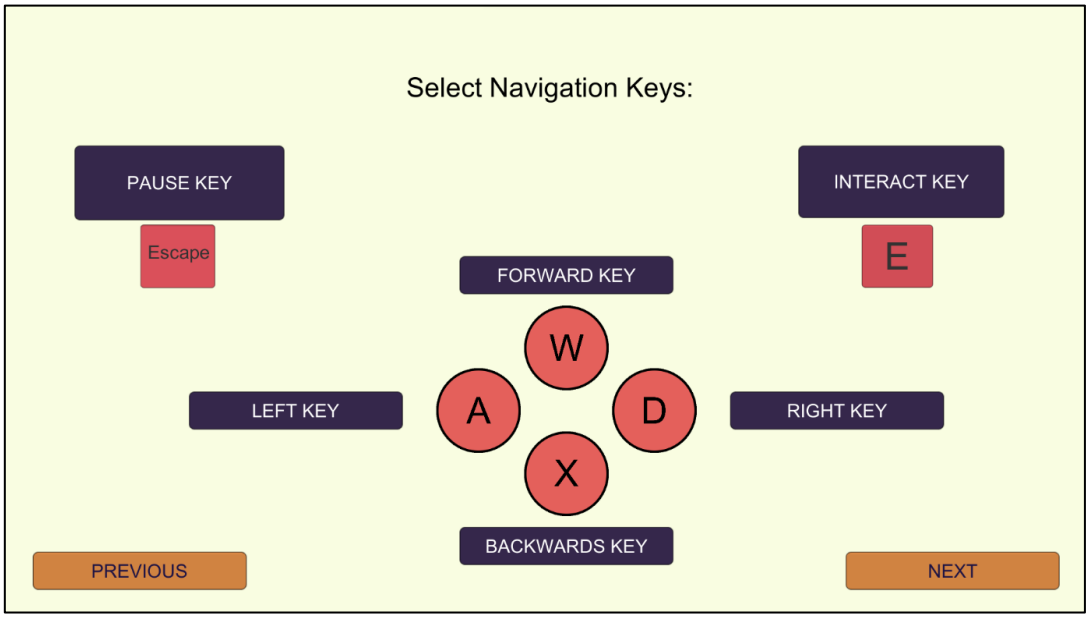
Skip

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

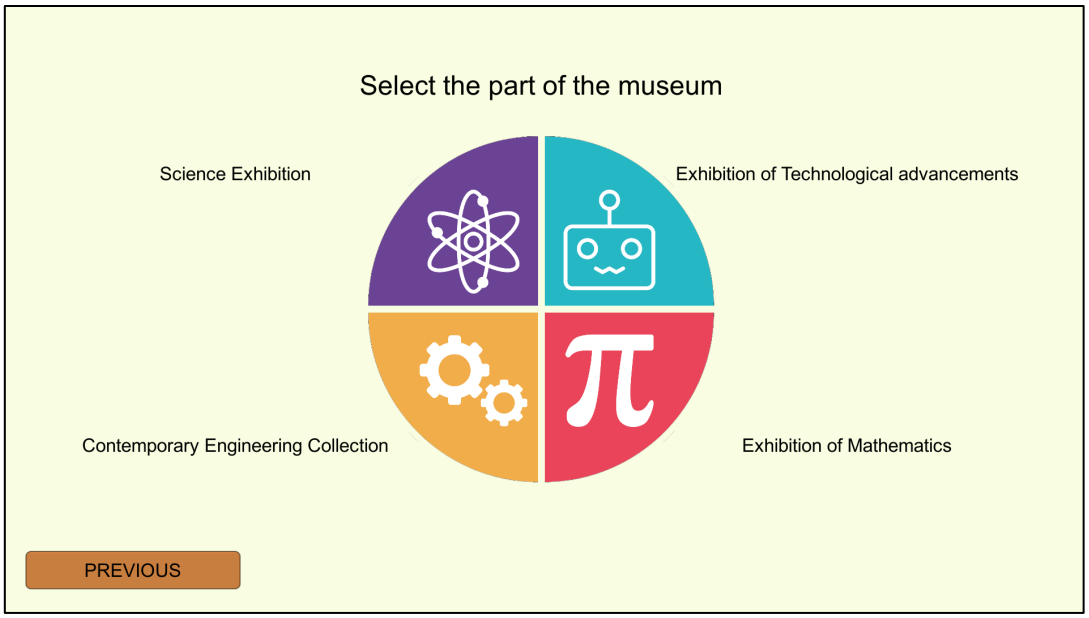
Skip

After the start screen the user can choose the language, but this parameter can be changed at any time during the visit. Once the user has chosen the language, they can click on the button next to continue.

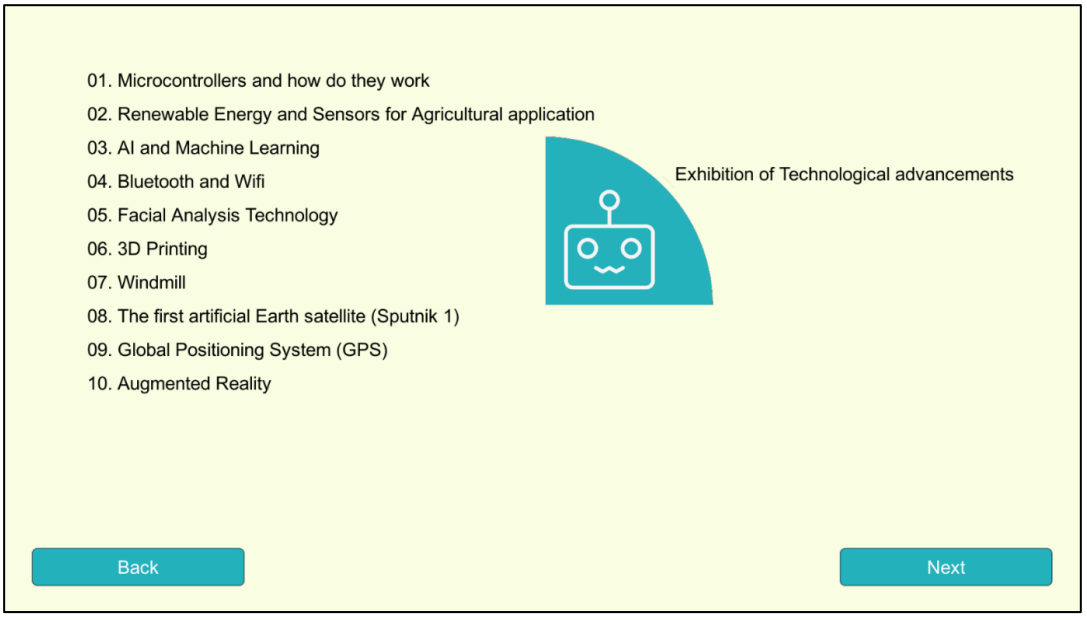
As keyboards are different in Europe, the user will be able to choose the keys they prefer to move insider the museum, if the user does not change the keys, the user advances with the default buttons.



The next step consists in choosing the part of the museums the user would like to visit.



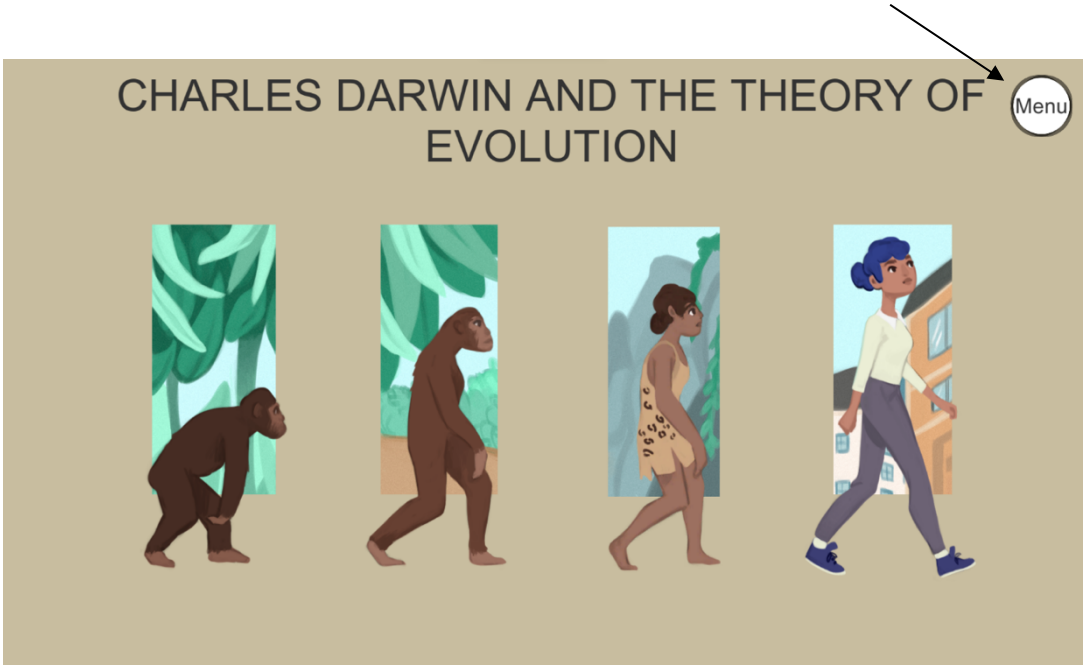
The user can choose from the four parts: Science Exhibition, Exhibition of Technological Advancements, Contemporary Engineering Collection or Exhibition of Mathematics. Once one of these parts is selected, the detail of the collection appears.



The button “validate” appears on the bottom right corner, once the user has clicked on the validate button, they are directed to the museum part chosen.

When the user is inside the collection visualizing one element, they can visit the other elements by clicking on the bottom right corner in order to switch. The menu can be used at any time through a button on the top right corner of the screen.

“Menu”



The buttons are visible and well contrasted to facilitate the access and avoid confusion while the user is moving around the museum.

REFERENCES

Daniela, L. (2020). Virtual Museums as Learning Agents. *Sustainability*, *12*(7), 2698. https://doi.org/10.3390/su12072698

Spector, J.M. (2014). Conceptualizing the emerging field of smart learning environments. *Smart Learn. Environ.* 1, 2 https://doi.org/10.1186/s40561-014-0002-7

CITIZENS IN POWER

Escola Profissional de Espinho

SREDNJA ŠKOLA IVANEC

LogoPsyCom

YuzuPulse

Funded by the Erasmus+ Programme of the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Project number : 2020-1-FR01-KA226-SCH-095602