

D4.3 – Delivery of the Natural History Education Pilot

This report describes the progress of the Natural History Education Pilot, from the co-creation workshop in month 5 until the final delivery of the Pilot in month 18. It includes a description of the Pilot, the content, technical developments as well as the evaluation and business model aspects. A summary of the Challenge event, the results and an assessment of the added value for the creative industries within this Pilot theme are also included.

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Executive Summary

The main aim of the Natural History Education Pilot is to demonstrate effective collaboration between memory institution and creative industry, using digitized natural history content (mainly natural history collections) published on the Europeana portal. Reasons for this collaboration are to develop products which can be used for educational purposes and introduce the natural history content via attractive and innovative way. This collaboration also represents a case study for the memory institutions and creative industry outside of the Europeana Creative project consortium. The development methodology, tools and also the product code will be provided to the creative industry via Europeana Labs. During the Pilot process an open Challenge was organised to attract creative industry representatives and to get their feedback on this innovative approach and inspire them to create new applications using cultural heritage resources. The winner of the Challenge and spin-off phase of the Pilot demonstrates a third case study of collaboration with the representative of creative industry outside of the project consortium, in addition to the two Pilot products.

As the Pilot uses a very innovative approach, several important lessons were learned. The Pilot outcomes are not just the case studies and the products but also the experience gained and various challenges taken related to the Pilot theme, content, development, collaboration and business models according to the actual situation. The Pilot works in this field as a prototype, and with deliverables from the other 4 themed Pilots in this project, this work will bring a very valuable analysis describing the processes and benefits but also potential challenges when it comes to the re-use of cultural heritage resources by the creative industry via the Europeana portal.

1. Introduction

The Natural History Education Pilot is developed within the Europeana Creative project. The project aims to demonstrate creative re-use of Europeana resources/content by developing test applications in five thematic areas: History Education, Natural History Education, Tourism, Social Networks and Design.

This deliverable summarises the progress and the delivery of the Natural History Education Pilot which was developed between month 5 and month 18 of the project.

The Natural History Education Pilot includes two products with different approaches in the field of Natural History Education. Both Pilot products represent the innovation model in education by gaming for variable audiences and implementations. The main aim is to introduce the natural history content to users in an attractive and interactive way in different environments such as family, school classes or museums. In addition, the Pilot serves as inspiration for creative industries to build on top of the concepts or create their own.

The Pilot core team contains of four partners: two are memory institutions as National Museum in Prague (NMP) and Museum für Naturkunde in Berlin (MfN) and two are creative industry representatives as Exozet (XZT) from Germany and Semantica (SEM) from Slovenia. The team consists of representatives of natural history museums, natural history scientists, education specialists, applications and serious game developers and game specialists. The Europeana Creative project consortium also includes specialists in business modelling, evaluation and public relation and holds close collaboration with Europeana and the Europeana Network, to guarantee the delivery of successful Pilot applications.

2. The Pilot

2.1 Co-creation Workshop

During the project preparation two potential products were described within the Natural History Education Pilot (WP4) which were considered for development by the Pilot team, including two creative industry representatives. This team already started collaboration during the project proposal preparation and at the project kick-off meeting in Vienna (2013). But the important event for the decision of the Pilot products and kick-off the products development phase was the co-creation workshop. This event brought together not just the Pilot team but also experts from various fields as education, technical development, gaming, business and economy, museum collections and content curation. Due to this conditions and also the fact, that this was the first out of five co-creation workshop in this project (one for each Pilot), its status was quite unique. This innovative approach was new for the consortium members and also for EU projects.

The Natural History Education Co-creation Workshop (Fig. 1) was held in May 2013 in National Museum in Prague and was very successful. The workshop focused in its first part on the evaluation of available and by the participants favoured applications or games, which have the aspects of natural history education. The evaluation criteria were usability, innovation, complexity, engagement, learning potential and “europeanability” (Fig. 2). During the next day several teams worked on the preparation of potential scenarios and concepts of ideal products which will have positive rating for all mentioned criteria and afterwards those concepts were evaluated in the same way as the applications and games the day before. Several scenarios and concepts were presented, created, discussed and evaluated. There were also two concept drafts that were prepared before the co-creation workshop by the teams which were evaluated together with the drafts created during the co-creation workshop. The concepts preparation had several phases and at the end there were 5 concepts prepared for apps and games. Within the group there was the concept of the museum adventure game (Fig. 3) and two concepts of a card game (Fig. 4), which was the base for the two Pilot products. The third day focused on preparation and evaluation of business models of the prepared concepts. The business model canvas concept was used for the models brainstorming and discussions. During the last day in the afternoon there was a business model workshop organised, explaining for example market activity analyses. During the interactions within the groups various criteria were discussed for these analyses such as market forces, macro-economic forces, key trends and industry forces (Fig. 5). The business models aspects related to the Pilot products are described in details in chapters 2.2.4 and 2.3.4 in this document and also in the white paper document that was produced by WP3 ([White paper education](#)).

At the end of the workshop and during the post workshop evaluation it was decided that the Pilot will have two products. One focuses on the museum adventure game and another on the card game. During the event potential technical development aspects and procedures for the games and applications development were discussed too, which was very important for the Pilot team. After the co-creation workshop the Pilot products development started. For the development tracking and organising the Pilot team used an adaption for the Agile SCRUM

method ([Scrum software development](#); Fig. 6), with defined roles and regular Scrum calls using Google Hangout. The development process had an important milestone in September 2013, namely MS10, where a prototype demonstration to the consortium was held and the progress of the Pilot thus far was documented. For the development process overview the project communication platform Basecamp was used (<https://basecamp.com/1768384/>) as communication tool and the Trello project organiser board (<https://trello.com/>). It is important to mention that the co-creation workshop was very valuable for the Pilot and a good approach, complementing the Agile SCRUM software development method. Both Pilot products are described in details in the following chapters.



Fig.1 Natural History Education Pilot Co-creation Workshop in Prague.

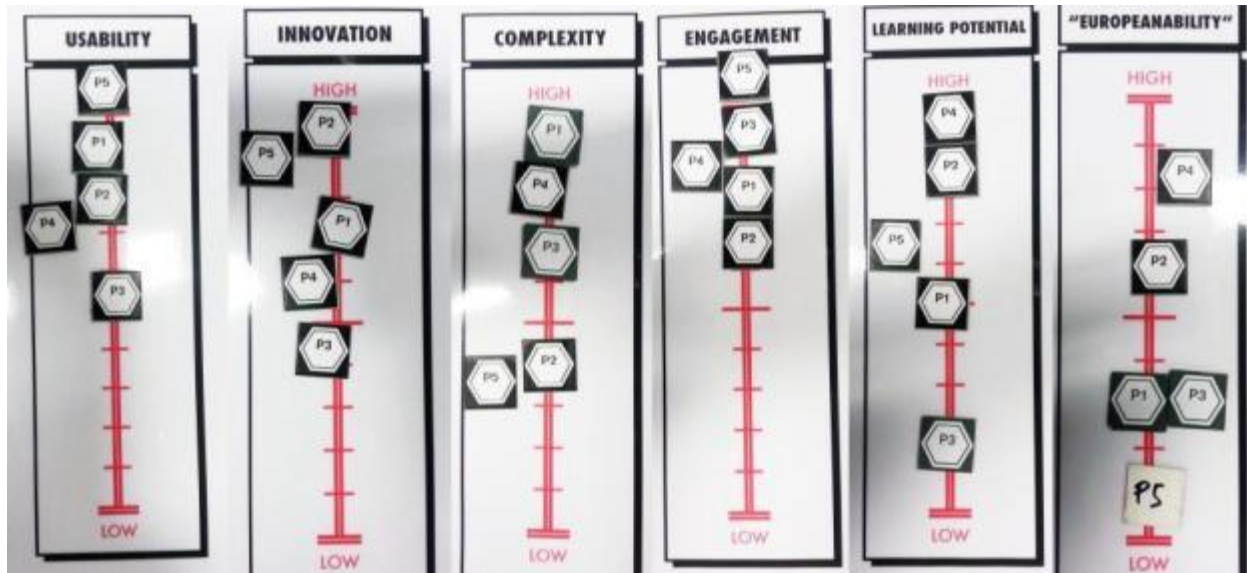


Fig. 2 Concepts evaluation criteria

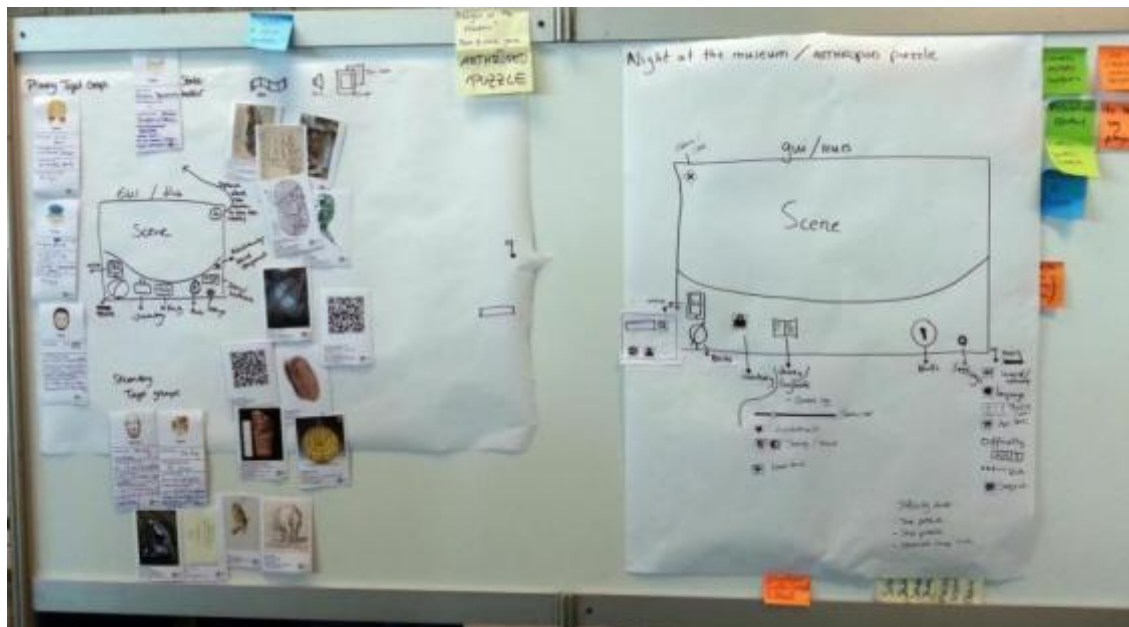


Fig. 3 Museum adventure game concept board



Fig. 4 Card game concepts boards

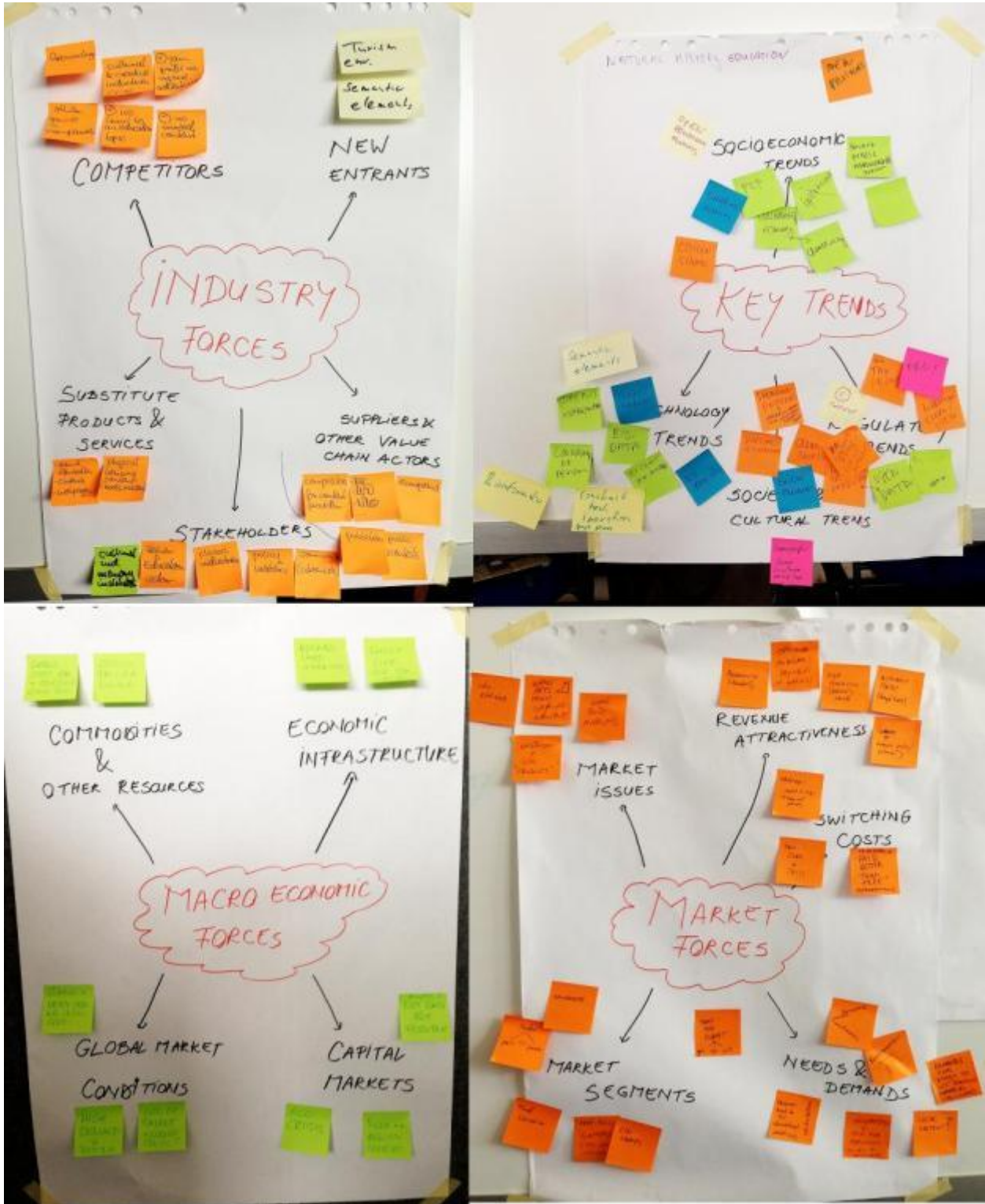


Fig. 5 Business criteria boards

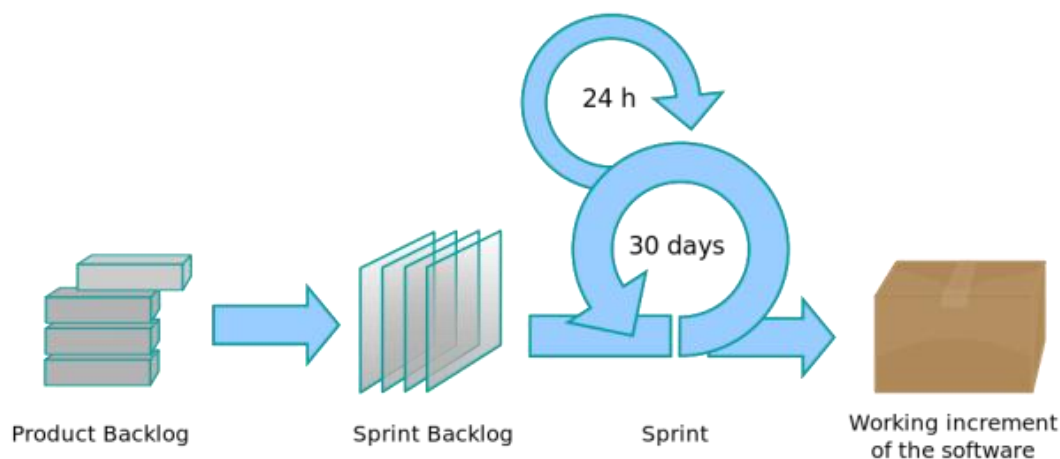


Fig. 6 Scrum process by Lakeworks - Own work. CC BY-SA 3.0 via Wikimedia Commons
[http://commons.wikimedia.org/wiki/File:Scrum_process.svg#mediaviewer/File:Scrum_process.s
vg](http://commons.wikimedia.org/wiki/File:Scrum_process.svg#mediaviewer/File:Scrum_process.svg)

2.2 Museum Adventure Game: The Secret Legacy

2.2.1 Pilot Concept

The adventure museum game “The Secret Legacy” was developed by partner Exozet Games. The main task of the Pilot is to show the digitized natural history collections content, published on Europeana, in an attractive interactive way and to highlight its educational aspects. The digitization of the natural history collections is not just for the archiving/digital of evidence, academic and scientific purposes, but also for their publication on portals such as Europeana. Publication of this content is creating unique access to this material, because it is usually hidden for the visitors in the depositories and collections not public available. This game highlights the natural history collections content and shows the world in the museums and collections institutions behind the walls and doors, which are not accessible for the visitors.



Fig. 7 Secret Legacy game starting page

The game “The Secret Legacy” is a mix of a point-and-click adventure and a hidden object game. The user takes the role of a museum employee who has to solve a lot of puzzles to unveil a big secret. The game is divided into two chapters. The first chapter is situated in the building of the Museum für Naturkunde (MfN), the second at the National Museum in Prague (NMP). The player explores exhibition rooms, collection rooms and variable space, which are usually hidden to the museum’s visitors.

The storyline is linear, so the user needs to solve an active puzzle before he can continue with the next one. In addition he has to collect a lot of items. It is not possible to skip puzzles but the user gets hints if he is struggled so that he knows what to do next. The user will receive the hints from NPCs (non player character) or as monologues from the main character in the game. The user will also get additional information on locations and objects, which can be accessed through the tablet in the HUD (head up display).



Fig. 8 Artwork of NPCS

The game has to be played in landscape format; the main character will not be visible in the game (first-person view). It runs on iPads with iOS system. The target audience is 12+ but first user tests at MfN showed that also younger audiences are interested in the game. The game can be played online and in offline mode.



Fig. 9 Secret Legacy user interface

Items which are used from the Europeana database will be connected in the game via link to the according page at the Europeana database. Right after the user tapped on such an item he will get a message that the app will try to access the internet to show additional information about it at the Europeana database.

The “Secret Legacy” is a serious game and developed as a mix of fun and educational elements. While playing the game, the user will learn on various levels about natural history, science, museum’s tasks and much more.

The general learning goals for the game are:

- to give insights in Natural History Museums, their purpose and tasks.
- to create an emotional connection towards Natural History Museums.
- to create interest for biodiversity, natural history and museums.

The story in a nutshell

The story is divided into 2 Chapters. The location for the first chapter is the Museum für Naturkunde Berlin, the location for the second chapter will be the Národní Museum in Prague. The user will take the role of Sara, an employee at the MfN. She is a descendant of the famous German scientist and explorer Alexander von Humboldt. Sara finds an old letter of her ancestor von Humboldt, which contains some notes about an expedition of Humboldt and his friend Aimé Bonpland to Caracas in 1800. The user has to solve different puzzles. Only when the user solves all puzzles the big secret can be unveiled.

It's late in the evening when Sara makes a discovery while sorting some old documents in the basement. She finds an old folder from Alexander von Humboldt which contains some notes and a part of a very old map. Sara feels responsible for her famous ancestor and she wants also to satisfy her curiosity. She decides to unveil the secret. Sara has to solve many different puzzles and to collect a lot of items. For every solved puzzle she gets another hint. At the end of chapter one the last hint points to the Národní Museum in Prague. Sara decides to travel to Prague to disclose the mystery.



Fig. 10 Sara the main character artwork

Setting

As already mentioned before, the first chapter of the game is located at the Museum für Naturkunde Berlin and was developed with MfN and NMP, both responsible for the scientific and educational background. The location for the second chapter will be the National Museum in Prague. The concept of the second chapter with the puzzles details and settings is prepared as well but was not developed within the Pilot due to time and resource restraints.

Educational aspects

The educational aspects of the game are presented on various levels. At the beginning of the story line, Alexander von Humboldt, who was a very important person in natural history, geography and other fields, is introduced. In addition, the game aims at motivating the young scientist Sara to discover secrets, and making natural science more interesting. Part of Sara's motivation is also her responsibility regarding her ancestor, highlighting some principle values of family.

The most important educational value is represented by solving the puzzles and riddles using some basic traditional and also alternative methods in natural history research. Sara (and thus also the user) needs to learn and understand natural history methods and needs to gain knowledge to be able to solve the puzzles. The game includes a system of hints and thoughts of Sara, which should help the user in the process of the game. All of Sara's discoveries during the game are also recorded on her notepad, including additional information which is not necessary for solving the game but creates a wider knowledge background.

In the puzzles Sara also interacts with various natural history objects from Europeana that represent different museum collections. These objects have additional information, including links to the Europeana portal to provide the user with the possibility to get more information about them, but also to enable the user to see the objects in context with other content on the Europeana portal and other museum collections.

Another educational aspect is the environment itself. Together with Sara, the user will discover known museum exhibits as well as behind-the-scene locations; this enables the user to get a glance of what the museum looks like "in real" behind the "staff doors". Additionally the user is introduced to two Scientist of the MfN who appear as NPC in the game.

Puzzles

The first chapter of the game consists of eight puzzles. Six of them are located in the MfN Berlin and two in the Castle Tegel, plus a side quest.

Sidequest:

The user has to collect all butterflies that have been hidden at the different locations in chapter one. Right after the user collected a butterfly he has to put the butterfly at the right place in a collection box. The empty places in the box are marked by shapes of the different butterflies and the labels with the species names. The sidequest introduces the player to one of the museum's tasks: to create collections.

The user...

- ... gets an insight in a museum's collection by using butterflies of the MfN as examples.
- ... knows that this kind of specimens are stored in boxes and by using the butterflies from the MfN he will be able to describe the term "holotype".
- ... is introduced to the field of the biodiversity of butterflies.

Puzzle 1

At the museum's basement the user has to remove loose bricks at the wall and to pick up a leather folder with an old letter from Alexander von Humboldt containing information about an expedition of him and his friend Aimé Bonpland to Caracas in 1800. Before the user can put the old letter and the flashlight into his inventory he has to pick up the backpack. The next task for the user is to examine a collection room, where he finds an old box with some personal belongings from Humboldt. The user learns about the famous scientists, their research activities and relation to the museum.

The user...

- ... gains knowledge about the scientists Alexander von Humboldt and Aimé Bonpland and their relation to the museum.
- ... learns about the expeditions of Alexander von Humboldt and Aimé Bonpland to America.
- ... learns about the high historic value of many objects and thus natural history collections are an important part of the cultural heritage.

Puzzle 2

The user has to go to the wet collection of the MfN, where he has to collect different items: e.g. UV-flashlight and a glass container. The glass container contains a snail shell and a fish specimen of Tench *Tinca tinca* (Linnaeus, 1758) preserved in ethanol. The used specimen of *Tinca tinca* is the holotype of the species. The user has to remove the snail shell from the glass container and preserve the fish by refilling the container with the correct fluid. The snail shell is sealed with wax and the user has to use a clasp knife from his inventory to remove the wax and find a piece of paper without any text. The user gains knowledge about different types of collections in a natural history museum.

The user...

... is able to distinguish wet and dry collection.

... learns more about the preparation methods of wet collection objects, the used fluids and their specific safekeeping standards.



Fig. 11 Puzzle game screen

Puzzle 3

By using the UV-flashlight the faded text on the snail shell paper becomes visible. Among the text are some coordinates of Schloss Tegel in Berlin, the place where Humboldt grew up. The user is introduced to a research method to examine old labels used in the museum.

The user...

... gets to know the UV-lightning as a method to make a faded text readable.

Puzzle 4

The user needs to travel to Schloss Tegel and has to find the entrance, which is covered by grass. When he enters the hidden basement, he finds a lot of fossils. To find the next hint the user has to enter a number in a lock. This number is the starting point of the geological era Jurassic. To remember this date Sara has to assign dates with the right geological era. Sara finds an original bone of the *Brachiosaurus* skeleton of the MfN and takes it with her to bring it back to the museum. The user gets an insight in the field of palaeontology and learns about the history of earth.

The user...

- ... is able to order geological eras chronologically.
- ... gets detailed information about the geological eras of Earth's history and their most important events like the origin of life or mass extinctions.
- ... is introduced to different types of fossils, like inclusion in amber or bones.
- ... learns that most of exhibits in a natural history museum are real, e.g. the skeleton of *Brachiosaurus brancai*.

Puzzle 5

The user has to go the dinosaur hall of the MfN and replace the fake bone, which he found in Schloss Tegel, by the original bone in the skeleton. The user discovers the engraving "12 am" on the fake bone. It is 1 minute before 12 am so Sara decides to wait and to look what will happen. At 12 am sunbeam shines through the glassy roof and hits a floor panel in the mineral exhibition. Sara has to go the Minerals Collection and solve the puzzle by using the physical property of calcite and hematite. The user learns about the variety of minerals and the various properties and the range of application.

The user...

- ... is aware of the variety of minerals and their importance in our today's life by using the composition of many different minerals in our mobile phones and the associated ecological responsibility.
- ... learns more about the phenomenon of birefringence (optical phenomenon).

Puzzle 6

For her further investigations Sara needs access to a special part of the library of the MfN where only a handful of people have access. Therefore she goes to the scientist and curator Dr. Oliver Coleman. The user has to solve a classification task to get the door code from Dr. Coleman. He has to identify 4 species of amphipods under a stereomicroscope. The user will be introduced to research at the museum.

The user...

- ... gains knowledge about taxonomy, an important discipline of modern biology.
- ... learns more about classification as a part of taxonomy by using different species of amphipods as example.
- ... is introduced to one of the researchers at the MfN.
- ... learns about the job as a curator.
- ... is introduced into the literature search as a part of the work of scientists.

Puzzle 7

The user has to enter the code he got from Dr. Coleman to enter the library. The user needs to find a book for Dr. Coleman as well as the book of Alexander von Humboldt. In the library different books have to be checked out. After Sara finds the right books she has to bring the book to Dr. Coleman. The player learns about famous and important scientists and their books on natural history.

The user...

- ... gets information about four very famous scientists and their contribution to the modern biology: Lamarck, Darwin, Mendel and Linné.
- ... gains knowledge about their books on natural history and especially their theories of evolution or the creation of the binomial nomenclature, the basis of modern taxonomy.

Puzzle 8

The user has to open the book of Humboldt and discovers a dried spider inside the book. The spider has to be brought to Dr. Dunlop's office and handed over to him. Sara makes a sketch to remember the spider later. In order to do so the user has to puzzle the spider. The puzzle pieces show parts of two different species and the user has to pick the right ones. Dr. Dunlop gives the hint that colleagues from the Národní Museum in Prague work with these spiders. Sara decides to go there. The user gets introduced to museum's research.

The user...

- ... gains knowledge about determination of species by using a detailed observation of different features of spiders.
- ... gets another example for a scientist working at the MfN.
- ... learns about the collaboration of museums.

2.2.2 Content

The natural history content on Europeana was originally represented just by a few numbers, which included mostly natural history literature, art work and old photo documentation. This situation was changed by the Opening up the Natural History heritage for Europeana project (OpenUp!, 2011-2013). This EU funded project ended during the first year of Europeana Creative, but provided more than 1.5 million content items, mostly of collections specimens (in 2014 the number is around 2 millions). Since there is already a certain amount of natural history content on Europeana, it was necessary to do a content analysis and selections according to the topics, species and groups, image quality and composition, education and visual value and licences. The content used in the museum adventure game came mainly from the collections of Museum für Naturkunde in Berlin and National Museum in Prague, which both were partners in the OpenUp! project and published their content on Europeana.



Fig. 12 Basement of the castle Tegel with collection materials from MfN and NMP.

The objects from the Europeana database were used in different ways. Some objects are integrated as “active” objects, which means that they will be actively used by the gamer, e.g. *Tinca tinca* in “The Sink” to continue the game flow. Many of the objects are used to bring life to

the room's background as for example the pictures of crustaceans at the wall in the office of Dr. Coleman. Most of the Europeana content is assigned to additional information. The user can learn more about the objects regardless to the regular game flow. These Items are connected in the game via a link to the related page on Europeana. Right after the user taps on such an item he will get a message that the app will try to access the internet to show additional information about it on Europeana.

Different types of Europeana content are used in the game.

1. Content with relations to a famous person

In the game personal belongings of Alexander von Humboldt and mineral specimens which are collected by him are shown in the game. Also a fish specimen of the famous fish collection of the German scientist Marcus Elieser Bloch is used.

2. Content of famous specimen

The game features a part of the well-known *Brachiosaurus brancai* skeleton and the primeval bird *Archaeopteryx*.

3. Content which is necessary for the story line

Some Europeana objects were crucial for the story line. For example the snails shell in the wet collection puzzle. This specimen was found by Europeana search and is provided by the Natural History Museum London, CC-BY.

4. Interesting objects in the field of natural history

The game includes objects of various fields like butterflies, minerals or fossils.



Fig. 13 Specimen of ammonite *Mammites nodosoides* (Schlüter, 1871) from National Museum collections published on Europeana under CC BY 3.0 ([Europeana link](#))



Fig. 14 Specimen of crustacean *Schlueteria tetracheles* Fritsch, 1887 from National Museum collections published on Europeana under CC BY 3.0 ([Europeana link](#))

Content was provided by eight different content providers of the Europeana database. Other content providers are:

- The European Library (CC0)
- Natural History Museum London (CC-BY)
- University of Edinburgh (CC-BY)
- Austrian National Library (PD)
- Upplandsmuseet (PD)
- Rijksmuseum (CC0)

2.2.3 Technical Developments

2.2.3.1 Original Technical Concept

The goal of the Natural History Education Pilot was to demonstrate the effective utilisation of Europeana content in the natural history education domain, as an instrument to inspire the creative industry to build similar products.

Out of a wealth of game genres, the game was chosen to be a mixture of an „adventure game“ and a „hidden object game“. From a technical perspective, such a game is an interactive application with an emphasis on graphical presentation, slow pace with little or no real-time requirements, and the possibility to interrupt the game and resume it later at the current state. Specifically, the genre typically features *locations*, scattered *items* that the player can pick up into an *inventory*, and a series of *puzzles* where the player must combine items and on-screen entities to progress in the game's story.

The hardware platform targeted was an Apple Inc. iPad running the iOS operating system. The game was designed to run at a 1024 by 768 pixels resolution in horizontal orientations.

The game was planned to have an online and offline mode. In the online mode, re-used Europeana items would link back to the original Europeana item page. Apart from that, no real-time interactions between the game and the Europeana database / API were planned to make the game completely playable in an offline environment. To make up for that, the game was planned to feature an extremely simplified in-game Europeana database.

2.2.3.2 Game Engines Evaluation

Three game software development frameworks (game engines) were evaluated before the actual development started: *Multimedia Fusion 2*, the *Spark Casual Engine*, and *Unity3D*.

Multimedia Fusion 2 (<http://www.clickteam.com/multimedia-fusion-2>) is a software creation tool by the company *Clickteam* to build interactive game and multimedia applications. It emphasises ease of use and creation and replaces game scripting needs by an elaborate in-game logic editor. Its multi-platform export capabilities make it usable for cross-platform development. The software was evaluated because it has the potential to dramatically cut down software development time, leaving more budget and time for artwork production, which would be the largest asset in the game's project development plan. However, the result of the evaluation was that *Multimedia Fusion 2* was technically not on par with contemporary game creation frameworks, and it lacked an efficient asset tool chain to easily incorporate, adapt and manipulate artwork.

The *Spark Casual Engine* is a product by the company *Artifex Mundi* and is specifically designed for the creation of hidden object and adventure games. The company has developed over a dozen games with the engine, and released them commercially. The engine features an easy to use editor, in-game cinematics, visual effects, localization and multi-platform export. These features again would have reduced development significantly. Unfortunately, the company does not offer the engine for licensing any more. While they indicated that they might do again in the future, using the *Spark Casual Engine* was not a viable option for this project.

Unity3D by *Unity Technologies* combines a 2D / 3D rendering engine, a sophisticated editor, a comprehensive scripting environment and multi-platform publishing. The product aims at combining professional features known from its commercial competitors with a certain ease of creation, mainly provided by a large online asset store and a responsive community. *Unity3D* was the choice of the three engines considered, because it allows the greatest amount of freedom in development. On the other hand this means more developer time has to be invested, as all the game and interaction logic would have to be written from scratch.

However, with the infeasibility of *Multimedia Fusion 2* and the non-availability of *Spark*, combined with existing in-house knowledge of the engine, *Unity3D* was chosen as the technical basis for the Pilot game.

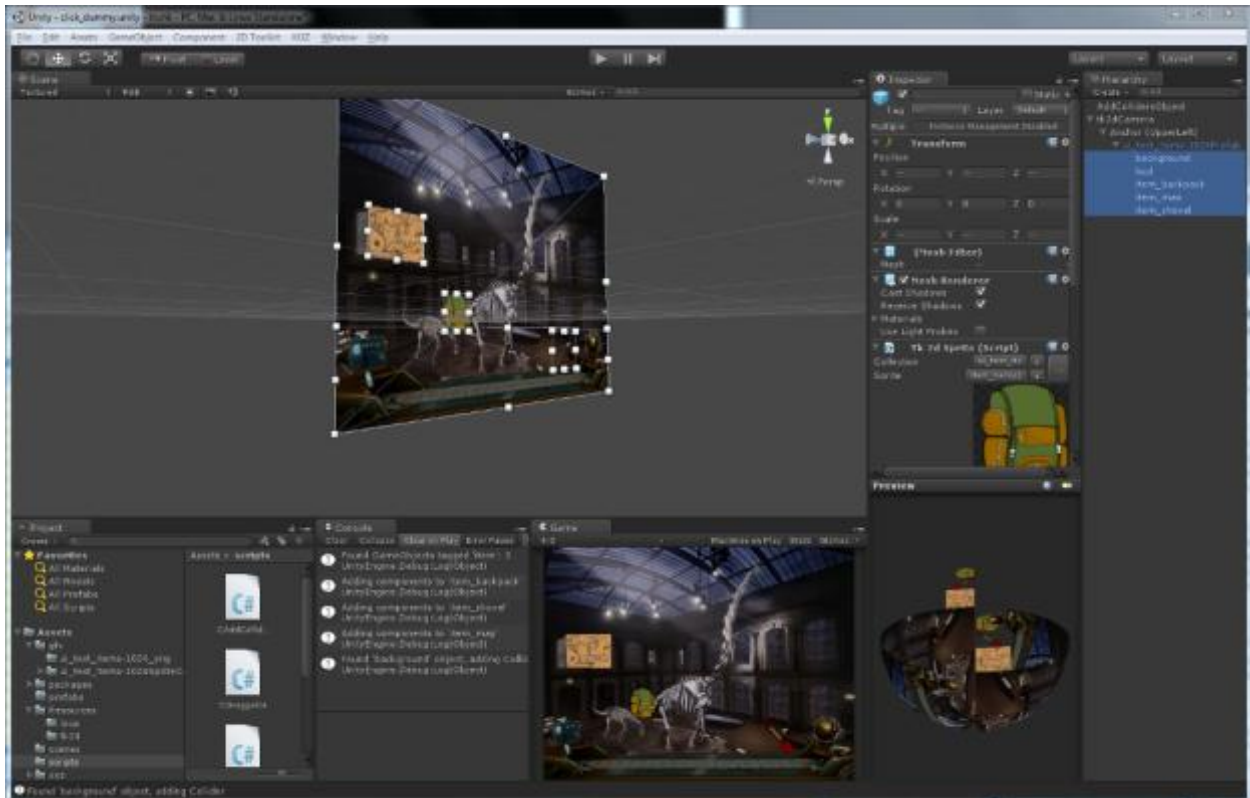


Fig. 15 Game concept in progress – screen form the Unity3D game editor

2.2.3.3 Technical Demo

The Unity3D game engine is being advertised as an all-purpose game engine, however its design prominently targets action-based games in a 3D space. To provide the development team with first hand experience, a proof of concept demo level was produced.

The technical demo was intended to implement core features of the game play interaction: item and inventory handling, talking to characters, and solving educational sliding puzzles on game sub screens. Puzzle 6 (see 2.1.2) fulfilled these requirements and was subsequently implemented in Unity3D.

Because no artist had been assigned to the project at this time, the demo had to use place holder graphics from a web search. This did not hinder the technical implementation, and in fact it proved that the underlying code was independent of graphical realisation. However as the copyright of the artwork used could not be obtained in all cases, the demo could not be published or circulated outside the Europeana Creative project partners.

The technical demo took about a month to be completed. It demonstrated the general feasibility of the Unity3D game engine for adventure and hidden object game development. In addition, it also revealed that using this engine, a substantial amount of handler code would either have to be written from scratch or bought as an add-on package for Unity3D.

2.2.3.4 Europeana Content Integration Process

Overview

The Europeana database comprises digital representations of cultural artefacts collected all over Europe. The majority of the material is image data, but it varies greatly in terms of quality, resolution and preparation, for example background removal. So far there are not any minimum standards that pictures have to adhere to, for example a minimal resolution and dpi (dots per inch) value.

Technical Considerations

The given resolution of the game – 1024 by 768 pixels – imposes the main technical restriction on what content can be used. While it is easily possible to shrink images larger than their desired screen size to fit the remainder of the screen, this cannot be done for images below their target screen size. The reason is that smaller images lack the detail information needed to reconstruct a larger representation, and consequently will look blurred or blocky on screen.

Another consideration is the presence of frames, backgrounds or artefacts as scratches or hairlines in the images. These would be tolerable in an application that displays images as-is, such as this project's sister application which develops a memory card game. In a game where Europeana items will be seamlessly integrated into a given background, possibly also matching the lighting, unaltered usage is not possible.

Design Considerations

While there have been attempts at adventure and hidden object games using real-life footage, the genre expectation is a hand-painted look. Given this design decision, the integration of photographic material becomes a challenge, as especially in a hidden object game, the items are not supposed to stand out from the remainder of the artwork.

The decision thus was to adopt a hand-painted style, and to re-paint the Europeana items from their photographs. While this added a considerable amount of artist work time, it solved a number of problems: the re-paintings could be done in a much higher resolution if required; any disruptive details could be left out; and the images can be made to match their environment.

Content Integration Workflow

Each Europeana item integration began with a design decision which item would make most sense in a puzzle or a scene. This was a joint effort of the game design team and the scientific advisors at the respective content providers. Together a fitting Europeana item was selected. After that, the art department re-painted the item, following the technical specifications of the development team. After that, the exported image could be imported into the Unity3D engine as a game asset, and be used as a texture in the game's rendering process.

2.2.3.5 Game Development

Requirement Analysis

Before actual development started, the game design document had to be completed. This kind of document describes a game in its entirety and it is the normative reference on how a game detail should be implemented. Once this document was available, the development team's first step was a requirement analysis, going through each scene, interaction and puzzle description and isolating the interactions patterns as well as the elements comprising the game state at each given step. From these requirements, a rough code structure could be devised. The game would be written in an object-oriented programming language, and the core abstractions could be defined beforehand without any actually working program code. This is a common software development procedure.

The analysis also revealed that the game required a lot of basic graphical user interface handling: screens and their traversal, dialogue boxes and buttons, list boxes and drag and drop items. Unity3D at the time only featured limited support for this. A common shortcut in such a situation is to use a third-party software library which provides the desired functionality.

External Libraries

The game uses one external library: the *Daikon Forge GUI Toolkit* (<http://www.daikonforge.com/dfgui/>), which provides in-editor graphical user interface creation with „what you see is what you get“-preview and draw call-optimised real-time rendering. For this kind of 2D point, click and drag interaction based game, this greatly simplified the development process, as results could quickly be seen and tested. In addition, the toolkit was usable by the art department, which could prepare the screen and item layout without a developer interfering.

One downside of covering these functions with third-party code was that its license prevented the game from being released under a permissive open source license, which would have been preferred by the consortium. But as the toolkit covered core functions, and no professional open source replacement was available, this was agreed upon as a viable decision.

In-house Code Base

One argument in favour of Unity3D during game engine evaluation was the presence of in-house development experience. This is laid down in a software library that implements core functions such as game logic, data serialisation and persistence, game state handling, and many more. These components are being used in several game projects and constantly improved.

The code base was used as the most basic foundation of the software product, with the object structure derived from the requirement analysis layered on top of it. This design allowed the development team to focus on puzzle and interaction logic implementation.

Game Framework Development

Even with a comparatively large code base for basic tasks in place, everything that happens on screen still has to be coded. The game framework that resulted from this step contains logics

and procedures for screen manipulation, abstractions for diegetic game elements, encapsulations for interactions, inventory handling and puzzles.

Screen Handling

A genre characteristic of a hidden object or slow paced adventure game is that it does not take place in an immersive 3D environment that the player navigates. Instead, it is played in a succession of full-screen images depicting the game locations, commonly referred to as *screens*. These screens may open additional smaller screens layered on top, for example for text display, dialogues or enlarged views of puzzle elements.

Consequently, a considerable part of the game framework deals with the handling of these screens. The *Base Screen* class covers the core functions: initialisation and de-initialisation, showing, hiding whole screens and single elements. It also manages selection of on-screen items. From that class, several sub-classes are derived that handle more specialised screens such as the menu or dialogues. The *Game Screen* sub-class and its derived classes handle the actual in-game screens with their respective specialised logic.

Gameplay Interactions

From the requirement analysis outlined above, a set of gameplay interactions could be derived, which each are covered by a specialised class in the program code. The general gameplay interactions are *picking up* items, *removing* items from screen, possibly bringing other items in view, changing the *inventory*, displaying *dialogues*, and opening further *screens*. There also is a *puzzle* interaction that points to more detailed implementations of single puzzles.

Interactive Elements

Gameplay interactions are bound to on-screen elements by the notion of *Interactive Elements*. Each item that is meant to be interacted with holds a list of possible gameplay interactions. This way, the player can carry out several interactions with a single element.

An interactive element abstraction also stores *preconditions* associated with interactions. Usually, a set of actions, such as collecting or moving an item needs to be taken before a desired interaction can be carried out. The interactive element abstraction ties gameplay interactions to preconditions and creates a dependency network along which the player works her way through the game.



Fig. 16 Game concept in progress – puzzle 7

Interaction Handler

Interactive elements contain the code and data for a single item, but cannot be used on their own. The *Interaction Handler* is an abstraction class that is queried each time the player taps or clicks an element on screen. It determines the element clicked and triggers the handling of its interactions. Once the element has successfully been interacted with, its state is set to *solved* and saved in the game progress.

Inventory Controller

In a mere puzzle game, players only interact with the items of a single screen. In an adventure-type kind of game, players collect items and carry them from screen to screen to possibly put them to use later. The *Inventory Controller* abstraction manages this collection of items. It offers a programming interface to put collected items into the inventory, query the set for a certain item, retrieve an item representation from the set, and save the current state of the inventory to disk.

Drag & Drop puzzles

The drag and drop puzzles in the game all feature the same pattern: on-screen items have to be moved from an arbitrary to a correct location. While there are some slightly different sub-classes, a general *DragDropPuzzle* class takes care of the basic interactions and checks. To ease the creation process, the game designer can lay out the puzzle in its correct order in Unity3D, and then set markers to where items should be moved when the player starts the puzzle. The class instance checks whether moved items have been dropped in or out of place, and takes appropriate action.

Game Editor

Even a comprehensive model of the game interaction is not practical if it is not accessible to a game designer, who is most of the time not a technical person. In the process of building such a complex software product as a digital game, empowering designers to create content without the intervention of a software developer is vital for an effective workflow.

With the game framework in place, a graphical game editor could be built. Using it, the game designer can combine the graphical assets and layouts contributed by the art department with the gameplay interactions and interactive elements from the codebase. Based on the paradigm outlined above, a designer can go from screen to screen and choose from a set of gameplay interactions when editing interactive elements. He can attach preconditions to the interactions and trigger events such as opening sub-screens or picking up items into the inventory.

Thanks to Unity3D's extension capabilities, the editor could be seamlessly integrated with the Unity3D editor. Core editor development took about six weeks' time, but it enabled designers, developers and artists to work in parallel and with much less developer intervention than before.

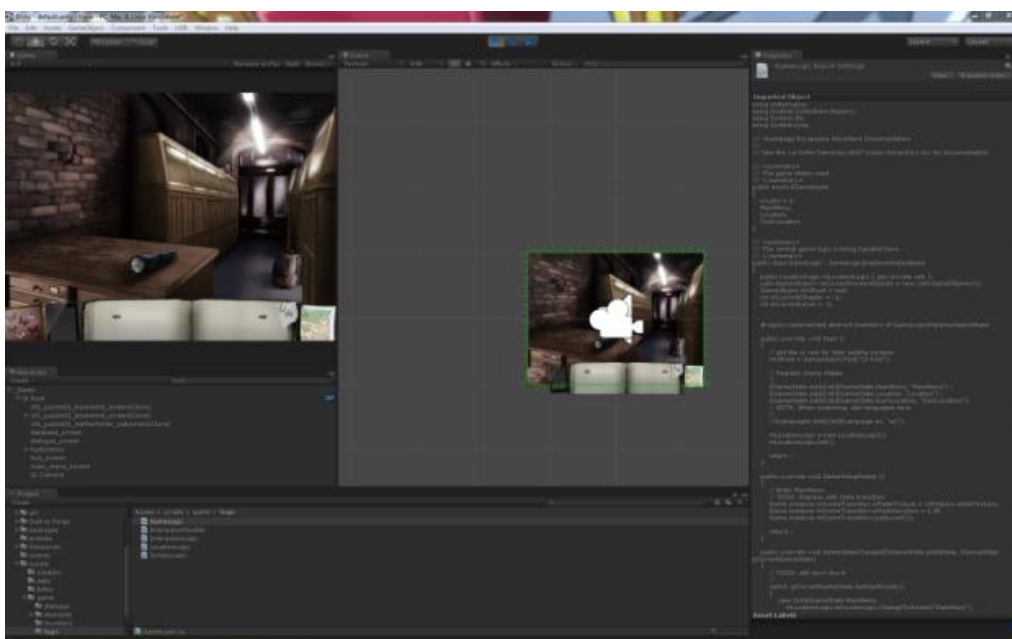


Fig. 17 Game concept in process – animation creation

2.2.3.6 Summary

Starting out from a technical concept, a complete adventure and hidden object game software framework has been developed on top of the Unity3D game engine. Outsourcing basic functions to third party software, a stack of game components has been devised to fit the needs of an educational adventure game as laid out in the game design document. The game framework, modelling the design requirements by class abstractions, has been made accessible by means of a graphical editor, allowing for a joint design and development effort by artists, game designers and developers.

While requiring more development time compared to simpler solutions, the Unity3D engine gave a lot more development freedom and fine-grained control over the outcome. Its cross-platform capabilities made it easy to circulate software builds for desktop operating systems while development was still in progress. The final game builds on a solid technical framework that demonstrates that it is possible to construct a workflow that incorporates digital cultural artefacts from Europe's into a professional-grade educational game.



Fig. 18 Adventure game Trello board

2.2.4 Business Model

2.2.4.1 Introduction

The first business models were discussed and introduced during the Natural History Education Business Model Workshop in May 2013, which took place after the brainstorming, concept design and rapid prototyping exercises of the Natural History Education Co-creation Workshop. It had the purpose of supporting the Natural History Education theme with identifying, implementing and analysing one or more business models via interactive activities and discussions. The working title of the concept at the time was “Night at the Museum”, “Secret legacy” now. Prior to the business model workshop, the Market Activity Analysis¹ was presented which identifies characteristics of successful collaborations between cultural heritage institutions, creative industries and other external stakeholders. Following the Pilot development a more elaborated document describing the business models development was prepared “White Paper: business models for (Natural) History Education” ([White paper education](#)). To develop effective business models in the field of Natural History Education re-using the digitised content on Europeana is quite a complicated task, because there are not many case studies especially in the educational field which can be used as example or as comparison and which are economically successful on the market.



Fig. 19 Business model workshop in Prague

¹http://pro.europeana.eu/documents/1538974/1594727/eCreative_WP3_ST3.2.1_CreativityTechnologyManagement_v1.0 accessed on August 27, 2014.

2.2.4.2 Business Model

The first discussion and concept development for the business model of the museum adventure game took place within the Natural History Education Business Model Workshop. The original business model canvas provided by Alexander Osterwalder & Yves Pigneur (BMICE, 2011) was used for better analysing the possible business model. The description of the canvas nine blocks is as follows.



Fig. 20 Business Model Canvas by Osterwalder and Pigneur

1. **Customer Segments:** The different groups of people or organizations which a business aims to reach and serve. The target audience for a business' products and services.
2. **Value Proposition:** A business seeks to solve customer problems and satisfy customer needs with value propositions. The products and services a business offers.
3. **Channels:** Value propositions are delivered to customers through communication, distribution, and sales Channels. The means by which a company delivers products and services to customers.
4. **Customer Relationships:** Customer relationships are established and maintained with each Customer segment. The link a company establishes between itself and its different customer segments.

5. **Revenue Streams:** Revenue streams result from value propositions successfully offered to customers. The way a company makes money through a variety of revenue flows.
6. **Key Resources:** The assets required to offer and deliver the value proposition to the customer segments.
7. **Key Activities:** The activities a business needs to perform in order to bring value propositions to its customer segments.
8. **Key Partners:** Some activities are outsourced and some resources are acquired outside the enterprise.
9. **Cost Structure:** The business model elements result in the cost structure. The monetary consequences of the means employed in the business model

The following information was collected during the business model workshop and further refined during the Pilot development (<https://bmfiddle.com/f/#/C2Wd7>).

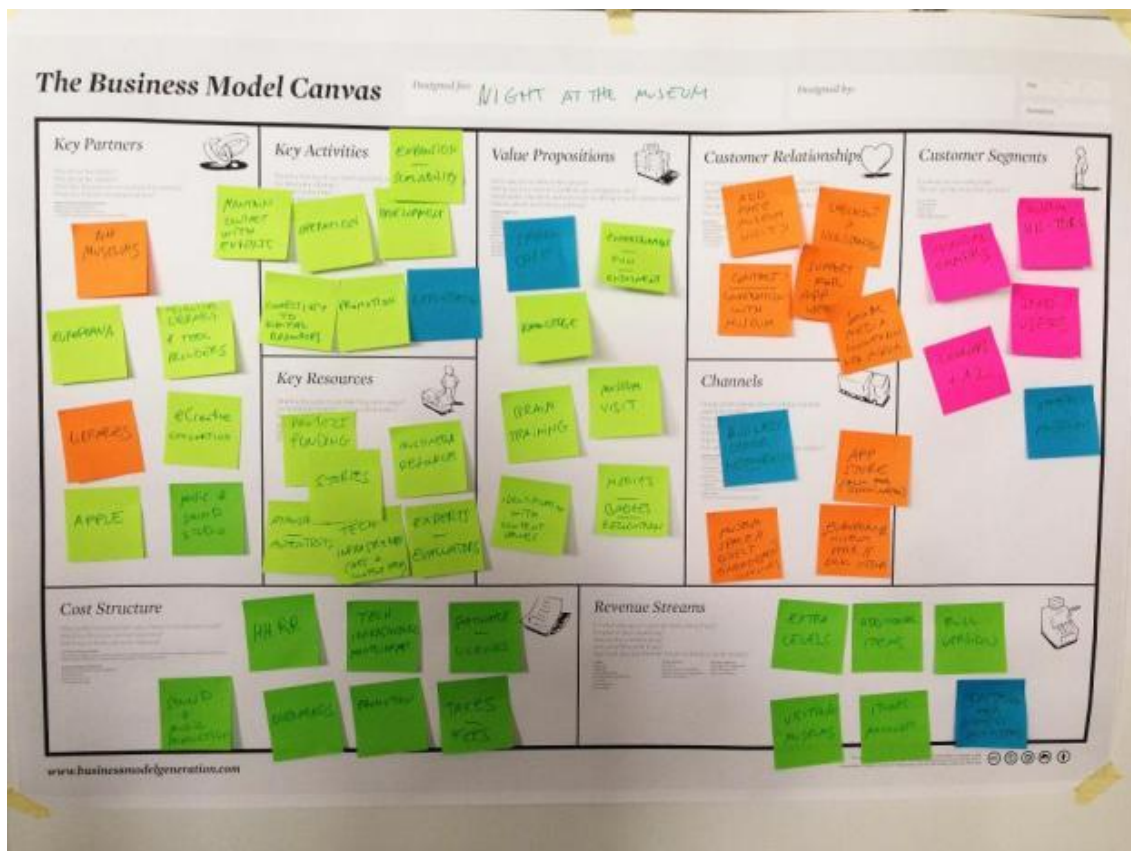


Fig. 21 Business model canvas board for museum adventure game

1. Customer Segments

- Museum visitors (children, families)
- Teachers and students
- Museums
- Educational institutions
- Game developers
- Technology providers
- Partners from the creative industries with a special focus on the gaming sector
- iPad users
- Families

2. Value Proposition

- Offers museum visitors, children and parents (informal education) and teachers (formal education) an application that is combination of fun and entertaining, socially engaging and educational in a way that something about natural history can be learnt.
- Offers museums an attractive game application which visitors can use to experience the museum's collections and exhibitions in a new way (digitally). This can stimulate people to visit the museum.
- Offers public educational institutions an attractive game application that educates in natural history themes.
- Offers game developers the opportunity to participate in an effort to deliver successful gaming applications for the museum sector with a chance of being adopted by museum visitors (reaching new markets).
- Offers technology providers a chance to promote their software and hardware solutions to relevant customer segments.
- Educational purpose: The game has a learning effect due to the used content, the introduction to museum collections, additional information on objects and scenes, interaction with content introducing the natural history science and research methodology/techniques, the visit of a virtual museum (exhibitions and behind-the-scenes area) and the story line combining history and natural history aspects (Alexander von Humboldt).
- Offers museums and educational institutions online learning resources for natural history education, interactive and innovative museum guide and promotion tools.
- Social recognition by solving the mystery
- A new way of experiencing natural history collections
- Showcasing natural history content

3. Channels

- Europeana & museum PR, social media
- Museum space, direct engagement (offline)
- App Store (also for dissemination)

- Business sector networking
- Developer marketing strategy

4. Customer Relationships

- Support for app users
- The consideration of offering direct contact to/conversation with the museums/content suppliers
- Social media connection with museum
- Registration option for user
- Add free museum visit as an option for purchasing the app
- Connection with museum activities

5. Revenue Streams

- Adaptation for other museums/institutions (consulting and projects)
- Use of different content/premium content
- Extra levels of the game can be purchased
- Possibility to download a full version
- Additional items that one can get via the game
- Visiting museums/promotion impact
- iTunes account
- Public–private partnerships with tech companies
- Governmental/public funding
- Philanthropic funding
- Corporate sponsorships (e.g., via sponsoring hardware)
- Crowdfunding
- Advertising

6. Key Resources

- Programmers
- Atmosphere/authenticity
- Project funding
- Experts/evaluators
- Multimedia resources
- Tech infrastructure (API and content data)
- Stories
- Puzzles

7. Key Activities

- Exploitation
- Expansion/scalability
- Maintain contact with experts
- Promotion

- Development
- Connectivity to digital resources
- Operation
- Designing/entertainment aspects creation/creativity and immersion development

8. Key Partners

- Europeana
- Europeana Creative consortium
- Natural history museums, archives, libraries
- Technical library and tool providers
- Apple
- Music and sound studios
- Game developers
- Education specialists

9. Cost Structure

- Tech infrastructure maintenance
- Taxes/fees
- Overheads
- Sound and music production
- Software/licences
- Human resources
- Promotion

2.2.4.3 Value proposition

The focus of the business model canvas lies on the value proposition. It's the magic fit between **what** you make and **why** people buy it". It solves the customer's problems or satisfies his or her needs.

Some value propositions may be innovative and can therefore represent a new offer. Others may be similar to existing offers on the market, but need to have added features and/or attributes² to be able to establish themselves on the market.

There are several examples for applications and services for natural history education, like the Evolution app of the Natural History Museum in London,³ which offers the possibility to explore more than 650 million years of Earth history. However, this is rather an exploration tool with no

² See Alexander Osterwalder and Yves Pigneur, *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*, Wiley, Hoboken, NJ, 2010, p. 22.

³ <http://www.nhm.ac.uk/business-centre/publishing/books/evolution/evolution-app/evolution-app.html> accessed on August 27, 2014.

game aspect. The same museum offers different games for children, accessible on the website, like “Mission: Explore”, where users can collect specimens and preserve them at the museum.⁴

In comparison with these examples, the Museum Adventure Game app combines both the exploration tool and the gaming aspect, by using Europeana content. Furthermore this application will be available as a download on the Apple App Store. The app is about fun and entertainment, and at the same time it has an educational aspect; therefore, it is considered to be valuable for a lot of different customer segments, as well as for the project partners involved in this Pilot.

The tool offers the Natural Museum in Prague and the Museum für Naturkunde in Berlin a valuable learning tool for visitors and users to virtually explore the museums’ collections; it is therefore an important step to increase the museums’ visibility and audience.

For Exozet Games, as a representative of the creative industries, this is a valuable exercise on how to collaborate with cultural institutions and how to make innovative use of cultural heritage content.

Last but not least the tool is a good promotion for Europeana’s high quality collections and content. It can be used as stimulator for other collaborations between cultural institutions and creative industries.

The following value propositions for educational re-use were specified for each of the stakeholders identified as important in delivering the central value proposition:

- For **content providers** (museums, archives, libraries) this means an extension of their public mission by giving access to and the possibility to re-use cultural sources / content for educational purposes. They can also use this to justify the need to digitalise their collections, as this gives wider access to cultural content to the public. Furthermore, the tool increases the use and awareness of the collections of the institutions by addressing a bigger community (students, teachers, families, gamers, etc.) through the combination of fun and education, and this gives a greater visibility to the institutions, and the needed justification for public funding to keep this kind of services/tools ongoing.
- The role of ICT in education is becoming more and more important. Also the use of ICT in museums and cultural institutions in general is growing. Therefore, **technology providers** are offered the opportunity to participate in this process, which will finally lead to a greater acceptance of this practice, to an embedding in the education sector and finally to more business opportunities and sales for this kind of products and services.
- **Education software providers** make use of computer software for teaching and self-learning. The software itself can be used by teachers and students to support teaching and learning with the help of ICT. The vast collection of educational software can be divided in two categories: content-free software that provides teachers and students or

⁴ <http://www.nhm.ac.uk/kids-only/fun-games/> accessed on August 27, 2014.

users in general with tools to create their own content, and offering open-ended software products that support the creativity of the user. The second type is the content-rich software, which comprises (multimedia) content in a structured way. Unlike content-free software, the user can rarely integrate his or her own material, as these programmes tend to restrict the level of user control.⁵ The Museum Adventure Game makes use of a content-rich software, with pre-selected Europeana content, which could be an useful example for education software providers looking for trusted and good quality content.

- Another creative industries stakeholder who is important for the Museum Adventure Game application is the **game sector**. New successful collaborations and partnerships between cultural institutions and creative industries can be established by re-using Europeana content.
- The Museum Adventure Game creates value for **public educational institutions**, like ministries, school, foundations and universities. The mission of these institutions is to make content available for everyone, having at the same time a clear educational mission. This is what the Museum Adventure Game accomplishes, and therefore this kind of application needs a guaranteed public funding. Another way of successful collaborations can be found in public–private partnerships.
- **Museum visitors:** *The museum visitor per se does not exist. We have to distinguish between the following types: the frequent visitor, the first-time visitor, the not-anymore visitor, the not-yet visitor and the non-visitor. The first four types are those that a museum usually targets with its marketing strategy. The non-visitor cannot be reached with this strategy, but rather by involving him or her in different projects. Looking at the Museum Adventure Game, there are different value propositions for the identified types. For the frequent visitors, the game is offering a different way of experiencing the museum and its collection. The first-time visitors can use the game to deepen their knowledge of the collections and therefore might feel the urge to revisit the museum. For someone who is not visiting the museum anymore, the game can reawaken the interest in the collection after playing it, and convince him or her to go for another visit. The same is true for the not-yet visitor, as this is a way of attracting new audiences who might like this kind of theme and content, but are not feeling the urge yet to visit a museum. And last but not least there is the non-visitor, who is the most difficult user to reach. By combining fun and entertainment with ICT and education, this type of user might be interested in the theme and may be convinced to at least visit the museum and its collection, in order to see the places he or she experienced in a virtual way.*
- Users: students and teachers, families, adventure gamers, iPad users

⁵ PDST Technology in Education, “Advice Sheet 21 – Educational Software”, November 2008, <http://www.ncte.ie/ICTAdviceSupport/AdviceSheets/>; accessed January 15, 2014.

2.2.4.4 Revenue streams

For the Museum Adventure Game we propose the following business model taxonomy / revenue models for the re-use of public content for the Natural History Education Pilot:

1. The first chapter of the Museum Adventure Game (set in Berlin) will be distributed for free via the Apple App Store market. The second chapter (set in Prague and other locations), as well as all other following chapters, will be payable content so the users need to pay to be able to access them. Revenue will be created by additional chapters, full versions but also by additional items that can be purchased (freemium business model).
 - Strengths and weaknesses: The fun and entertainment component of the game can create kind of an “addiction” for the user. By making the first chapter available to play and leaving the solving of the mystery open, the interest of the users in the game can be stimulated, so they purchase the next chapter to continue the quest.
 - Short- and long-term viability: Offering more versions or chapters of the game requires more resources and especially more content. At least for the second chapter of the game, additional funding is needed to finance the development and programming; especially after the end of the project funding, new means have to be found to keep this project going.
2. The game can be adapted for other museums and institutions (consulting and projects). The product owners can generate revenue by consulting offers from museums and/or project funding that are acquired from other (public) funds that align with the mission to make cultural heritage accessible in new ways.
 - Strengths and weaknesses: The game can contribute to an increase of museum visits because it offers a tailor-made experience of the collection in ways that museums have not offered yet. To get a good result, there needs to be a productive relationship between museum professionals and game developers, which requires investing time and money to invest in.
 - Short- and long-term viability: For the Pilot period this model is out of scope, but this can be explored as a model on the long term, to be repeated for other museums in either a standard service model offer or on a project basis. It is advised to start already within the project period to search for new funding opportunities.
3. **Merchandise:** While maintaining the basic version of the Museum Adventure Game free to use, the organisation can engage itself in business resulting in direct sales of additional goods. Because the game is targeted at consumers and tries to create a community of fans and players, fan merchandising can be an interesting way to bind the community and generate revenue. An example is the hugely successful

merchandise strategy of Rovio's Angry Birds game. For the Museum Adventure Game one can think of action figures or plush items that reflect the riddles that the user has to solve.

- Strengths and weaknesses: A strong community-building element. However, this cannot be the core business model of the game and relies heavily on an active fan community. Also, specific merchandising expertise in the team is needed which is not available at the moment.
 - Short- and long-term viability: It is advised to explore this model on the long term, once a strong fan base is created around the game.
4. **Philanthropic funding:** This is a frequently used method which could generate revenue to further develop the application. Revenue would mainly be generated from indirect beneficiaries (e.g., organisations, technology providers, companies, etc.) and not so much from direct beneficiaries (e.g., teachers, families, gamers etc.).
- Strengths and weaknesses: This model is a very powerful way to bind a community of users and get direct support from them in the further development of the game.
 - Short- and long-term viability: A very enthusiastic community of users is needed to be able to promote the game to donators. This should be established in the long run. As this model is highly dependent on the current economic climate, it was also noted that this model should not be considered as a standalone revenue source.
5. **Corporate sponsorships:** Support of the product by corporate members through money or know-how. It is also very useful to associate the product with commercial partners like Apple; this would lead to a higher visibility of the product and would attract more sponsors.
- Strengths and weaknesses: This model offers a powerful way for technology providers to enter a growing market with their existing software and/or hardware solutions, but it also requires that they meet the company's professional expectations, which will be high in the case of bigger brands like Apple or Microsoft; they may be lower for smaller technology companies.
 - Short- and long-term viability: It is advised to explore this model on the longer term if the product is mature enough to be presented to corporate sponsors.

6. **Crowdfunding:** A donation-based crowdfunding model seems to be the most suitable approach in this project. Especially families, online users and adventure game fans may have an interest in supporting the further development of the game. At the same time this means more control by the community, more feedback on the game and also direct feedback, if the game and the idea behind it are relevant to the targeted audience.
 - Strengths and weaknesses: The benefits for the community of fans that are enthusiastic about the game are high. They can influence the further development of the game and be part of the product.
 - Short- and long-term viability: It is advised to explore this model on the longer term if there is an established community to be targeted.
7. **Advertising:** Online advertising is widely spread and a good way of generating revenue. For this approach, the right partners have to be chosen. Serious advertising is needed to keep the quality of the application high; advertising partners that have the same customers as the application should be chosen (e.g., eLearning products, education products and offers, etc.).
 - Strengths and weaknesses: A proven model to generate revenue, although, if used in formal educational contexts, it is too commercially driven. As the main customer of the Museum Adventure Game is more broadly focused on consumers, this might not be a problem.
 - Short- and long-term viability: It is advised that this model is considered on the longer term because it is important to choose the right (thematically close) and serious partners for this. However, it is advised to develop this network of partners during the project period.
8. **Public–private partnership:** This model can be useful for the Museum Adventure Game as it can attract important new partners (e.g., Apple) and new resources, services and know-how. At the same time it can generate revenue (e.g., educational publishers, technology providers, etc.), and even reduce funding needs via indirect beneficiaries (e.g., technology providers).
 - Strengths and weaknesses: This is an opportunity to create new alliances and to get support from other key stakeholders. However, it is very important to define targets, tasks, duties and limits of this partnership from the very beginning, to assure a good outcome and a long-running collaboration.

- Short- and long-term viability: It is advised to explore this model on the longer term if the product is mature enough to present it to potential private partners.
- 9. **Selling audiences** to businesses is, again, a business model in which customer-related information is sold to data-mining agencies, but maybe also museum marketing departments around Europe. The advertising model is seen as supportive to the goals of the Museum Adventure Game.
- Strengths and weaknesses: The model aims at a deeper knowledge of users or viewers which caters the increased needs of (public) organisations to develop content that interests their public most.
- Short- and long-term viability: It is advised to explore this model on the longer term if the product is mature enough and the community is big enough for the marketing intelligence to become valuable.

2.2.4.5 Stakeholders

The Museum adventure game is considered to be valuable for a lot of different stakeholders in the educational field:

- (Europeana) content providers (museums, archives, libraries)
- Technology providers
- Education software providers
- Partners from the creative industries with a special focus on the gaming sector
- Adventure Gamers
- iPad Users
- Educational institutions (ministries, schools, foundations, universities)
- Museum Visitors
- Students and teachers
- Families

2.2.4.6 Earning Models

From the business model canvas, these were the values customers might be willing to pay for:

- Adaptation of the same principles: creating a game with Europeana content for other institutions.
- Distribution of the game via iTunes App Store as a free-to-play game will enable us to offer paid content for the game, such as:
 - extra levels;

- additional items that will help playing the game (e.g., hints for solving the puzzles);
- offering a limited version for free and selling the full game.
- Attracting a broad audience to visit museums more frequently.

The game with a first chapter (situated in Berlin) will be distributed for free via the iTunes App Store. The second chapter (Prague and other locations) will be payable content, so the user needs to pay to be able to unlock this chapter. The same model will be applied to all other chapters. The prize can be variable according to the chapter's size. The prize for the second chapter was not estimated yet, but according to the general price structure in the App Store, it will not exceed the five Euro limit.

2.3 Memory Card Game: ‘Memory match - the natural history collection’

2.3.1 Pilot Concept

The concept of the second Pilot product was refined several times, starting from the project proposal, through the Natural History Education Co-Creation Workshop and Business Model Workshop and subsequent Pilot team Scrum calls. Four different concepts were considered until the final concept was agreed upon and developed by Semantica. The final chosen concept is an educational Memory Card Game in which the user plays alone or against another user to find matched pairs on the board.



Fig. 22. Loading screen of the Memory match game

The game includes predefined sets of cards according to several attractive themes as minerals, fossils, insects and animals. The sets are built from preselected content on Europeana and content from the content providers MfN and NMP. The game is a regular memory card game as it is already well represented on the market, with several unique options and extensions that improve the added value and educational aspects.

The first extension are the quiz questions which must be answered to get the score from finding a pair of cards. For each of the card/species or object there are 3 related questions with 3 possible answers where only one is correct. Those questions have various difficulties and appear randomly when the pair of cards is found.

The second extension is the option for the user to create its own set via the Europeana API. The API is in this version of the game connected to the preselected content on MyEuropeana account. A possible extension for this option is to create a special MyEuropeana account for the user. The user will then be able to tag the content on Europeana and will be able to create their own memory card set, but without quiz questions. Another option is to connect the game directly with Europeana using the API and allow the user to search the whole content with suitable licences and minimum resolution requirements. The problem lies in the diversity of the content on Europeana from which is not possible to select only natural history content. This extension will turn the game to the effective tool which can be used by lectors, teachers, students, parents or children, to create specific sets for specific purposes.

Following the API extension, an additional option will expand the game with the possibility to create their own quiz questions for the personalised sets.

Because the source code of the game will be available, there are plenty of options for its re-use and modifications. One of those options can be to adapt the game for the museum exhibitions touch screen. The museum will be able to populate the game by its own content from Europeana and create quiz questions or additional information, which will appear when the user/visitor will find the pair of cards. This information can for example explain the object value, its location in exhibition or some trivia, which can be part of the working sheet tasks for schools. This concept was already evaluated as very valuable interactive element in the exhibitions.

The functionalities and elements implemented to the Pilot are described in more detail below.

Card sets

There are four pre-prepared game sets available, covering the various fields of natural history. The first prototype set is the mineral collection set, including content from MfN and NMP collections. The set includes colourful and attractive minerals. This is a larger set which is also possible to play on extreme level of difficulty (see below). Other sets were created in parallel with the development process. The fossils collection set includes specimens from various stratigraphic age and groups as fossil plants, vertebrates and invertebrates to show the user the variety of the past. The insect collection set is showing the diversity of the insect world. The last set is mainly addressed to young children including the colourful illustrations of animals.

- Minerals (42 pairs)
- Fossils (32 pairs)
- Insects (32 pairs)
- Animals (32 pairs)



Fig. 23 Set of cards and difficulty selection

Quiz questions

All pre-prepared sets include quiz questions. There are three different quiz questions available for each object, with three possible answers – one of them is correct. Questions are displayed randomly but related to the specimen or object. Those questions have educative character and reveal interesting information about the card or theme and also encourage the user to study the object and find out the right answer to get the score points from finding the pair. Because the one out of three possible question for each card is chosen randomly, there is guarantee, that the level of question repetition will be reduced.

Several questions examples:

Some insects are essential to the life-cycle of many flowering plant species. They are called a) predators, b) pollinators, c) parasites.

Find the false sentence. a) Ores are minerals with an ornamental value, beauty, durability, and rarity. b) Gem minerals are often present in several varieties, and so one mineral can have several different gemstones. c) There are about 20 mineral species that qualify as gem minerals.

Tyrannosaurus rex (Osborn,, 1905) was one of the largest land carnivores of all time. The largest complete specimen named "Sue" measured _____ long, and was _____ tall at the hips. a) 2.3 metres, 1 metre; b) 25 metres, 8 metres; c) 12.3 metres, 4 metres.

The St. Bernard dog became famous through tales of rescues from a) fire, b) avalanche, c) tsunami.



Fig. 24 Quiz question in minerals set.

Level of difficulty

The difficulty in the game is related to the number of pairs on board and the quiz questions. It is possible to select 5 various sizes of the boards from 6 – 42 pairs according to the concrete set. The new set must have at least 6 pairs to reach the minimal level of difficulty.

- Easy – 6 pairs
- Medium – 12 pairs
- Hard – 20 pairs
- Harder – 30 pairs
- Extreme – 42 pairs

Single and multiplayer

The game can be played in single or multiplayer mode. In the single mode the user can test his memory and also knowledge of the various topics in natural history. In the multiplayer mode 2 players can play the game in same time on one board. The motivation here is to beat the opponent by higher score from the pair matching and quiz questions answering.

Game Complete/Best Score

At the end of the game the “Game complete” pop-up shows. The 1-player mode also includes the best score functionality.



Fig. 25 Score in multiplayer game.

Create your set

Users can create their own card sets to play with. This option is connected with preselected content on MyEuropeana account created for this game. There is limited number of search terms according to the content metadata. User can tag the images and when you have selected at least 6 cards, he can name and save his set. Than in the menu play will this set appear and is playable in difficulties according to the number or pairs. This set is working as classical memory match game without quiz questions.



Fig. 26 Create and name your own set.

About/Help

The About section contains information about the game and instructions for playing. The section can be accessed from the Home screen (About) and the Play screen (“?” icon).

The “How to play” section contains a slideshow of screenshots with instructions, allowing users to move forward and backward between screenshots.

2.3.2 Content

The content for the memory game was selected directly searching available Europeana content. Thanks to the OpenUp! Project the NMP has a good overview about the potential content on Europeana, but the content selection was a relatively long process. First several themes were selected according to the content availability and then a list of potential species was created. Not all species or objects had a good quality photos so the list of the species for the game sets were modified according to the content availability, quality and licences on Europeana. Because of the Europeana API and complication to select just natural history content on Europeana, it was necessary to find an optional solution for how to group content and make it available for the game. A good solution was to create a MyEuropeana game account and tag the preselected content for the sets. For the game it was also important to

select content which has a good quality thumbnail on Europeana or a direct link to the repository. All those criteria reduced the pool for the content selection.

The content for selected sets and tagged on MyEuropeana is from various content providers including NMP, MfN, Rijksmuseum and others.

The content also represents rich editorial where it was important to create 3 questions with 3 answers for each questions. This resulted in 414 questions with 1 242 answers.



Fig. 27 Minerals, Insects and Fossils sets including the digitized natural history collections content published on Europeana

2.3.3 Technical Developments

2.3.3.1 Europeana Re-use

The game focuses heavily on Europeana re-use, so all the content in the app is provided by Europeana directly, via Europeana's API. Since this is a "Natural History" Pilot, we wanted the app to be limited only to the correct type of content. The Pilot team decided to use a different version of the API - called MyEuropeana. **MyEuropeana enabled us to preselect content**, which is already in Europeana. This new MyEuropeana integration enabled us to limit the app to quality content selected by NMP, while still using the **Europeana API**. The code that we created in this Pilot, can be easily re-used for full Europeana API integration, simply by calling a different API endpoint.

2.3.3.2 Proxy Server Implementation

Since the used Europeana API (My Europeana) requires authentication of the user it was decided that a proxy server between the game and the Europeana API is to be implemented in order to simplify manageability of the Pilot implementation. To further clarify, this allows us to modify the way data in Europeana is accessed without the need to modify / update any of the clients, while at the same time greatly simplifying the future game development.

The proxy server was developed using:

- Microsoft .NET Framework 4.5
- Microsoft MVC Framework 5
- Microsoft MVC Web API 2
- Newtonsoft.Json Parser
- Microsoft OAuth Libraries 2

Development was done using Microsoft Visual Studio 2013 and the solution is hosted in the Microsoft Azure Cloud as a Shared Web Site.

The Proxy server accepts a search request from the client (game) in the JSON format containing the requested search query. The server then logs into the Europeana API (specifically My Europeana) and retrieves the list of objects stored in the account that have been preselected for game use. It then filters the list using the specified search parameters and returns a JSON response containing a list of the URLs to the images of the objects.

The call from the game to the Proxy server is unauthenticated, whereas the calls to the Europeana API are authenticated using the API key and login cookie, when required.

To enhance performance, the server caches the results from the Europeana API calls, since this can take some time, especially when login is required or a large number of objects is returned.

Further documentation on API used in the development can be found here:

- <http://labs.europeana.eu/api/myeuropeana/>
- <http://labs.europeana.eu/api/record/>

2.3.3.3 Game Implementation

To simplify development for multiple platforms, a framework was used for development. Specifically, the game was developed using the following technologies/frameworks:

- Unity 4.5.3
- UnityVS
- Visual Studio 2013

Unity is a game engine capable of targeting multiple platforms using a common source code base and was chosen for its support of the following platforms: Windows Phone 8, Windows, OS X, Linux, Android, iOS and others; thus covering the use of the developed Pilot on all of the most popular mobile platforms today.

To simplify development with Visual Studio 2013, we used a plugin called UnityVS, simplifying the development workflow and especially debugging of the developed unity app, using the Visual Studio Integrated Development Environment.

The Game could roughly be divided into the following functional units:

- Game Engine: developed using C#, the game engine tracks the state of the game and enforces game rules, like scoring, generation of puzzles and multiplayer support.
- Interaction Layer: developed using C#, the interaction layer ensures sound playback, animation playback, transitions between screens, popups and manages human interactions (interpreting clicks, touches, swipes, etc.).
- Rendering Layer: developed using Unity, it defines the actual animations and transitions used during gameplay. It also displays all graphics and the user interface to the end user.

All three layers are then packaged into an executable application using the Unity Framework and can be distributed via standard channels for each particular platform.

More about the technologies used in the game development and their documentation can be found here:

- <http://unity3d.com/unity>
- <http://unityvs.com/>



Fig. 28 Memory match game editor in Unity3D

2.3.3.4 Game code

Similar to the Museum Game Pilot, this game is built on top of the Unity3D engine, which enabled us to build a multi-platform solution, which can be run on Windows, Mac, iOS and Android.

2.3.4 Business Model

2.3.4.1 Introduction

The final concept for the Memory game was developed after the co-creation workshop during the development process. During the co-creation and business workshops was developed similar model for the card game named “Save the Species Card Game” (Fig. 30). For the business model development and evaluation the same method as for the memory card game was used. The models are different according to the character of the products, audience and re-use though.

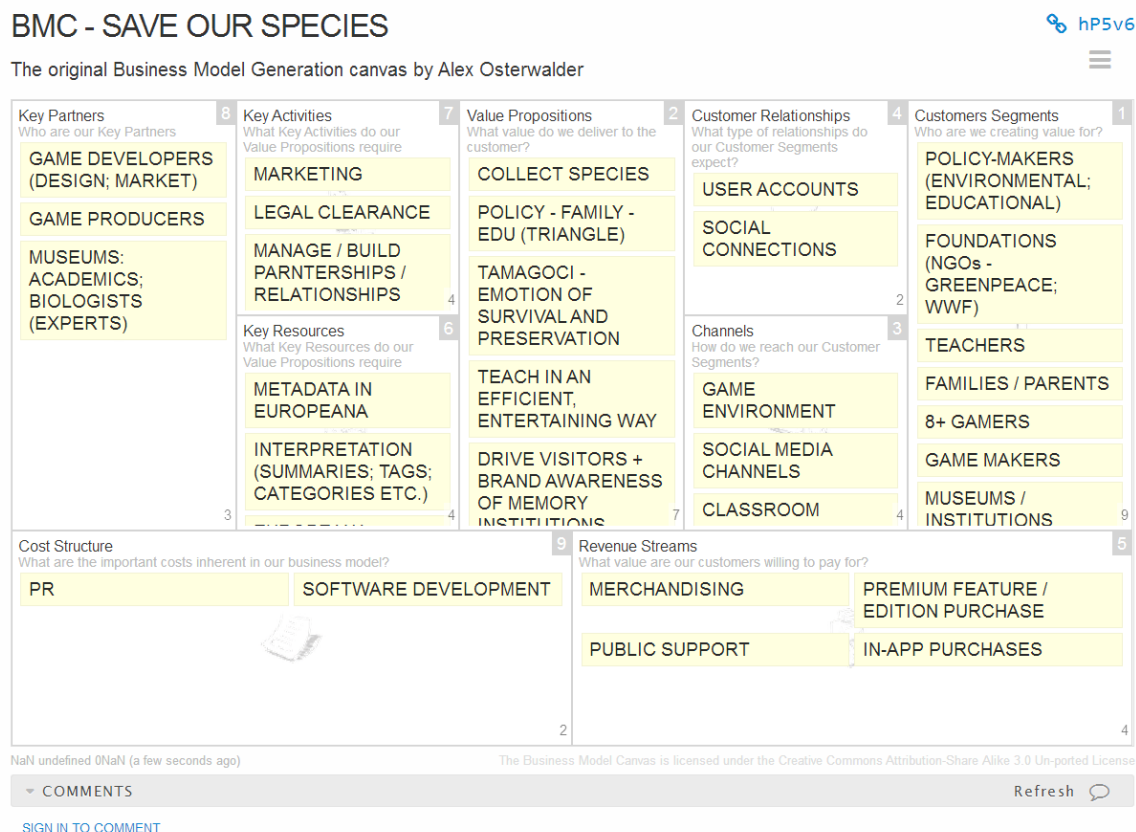


Fig. 29 The business model generation canvas for the “Save the Species Card Game” (<https://bmfiddle.com/f/#/hP5v6>).

2.3.4.2 Business Model

The following business model canvas was developed and fine-tuned for the Memory Card Game:

1. Customer Segments
 - Pre-school and elementary-aged children
 - Teachers and students

- Parents/families
- Museums / content providers
- Game developers
- Technology providers

2. Value Proposition

- Collect your favourite species from a curated and preselected set of quality content about species.
- Access to a fun and educational game application with which children, teachers and parents can build their own quiz; museum educators can build quizzes for their exhibitions.
- Increase of the use of natural history collections by children, teachers and parents and additional marketing intelligence about these target groups.
- Increase of the chance that children, teachers and parents who play the game will also visit the museum in which the object is exhibited (via the inclusion of location information about the exhibited objects).
- Offers game developers the opportunity to participate in an effort to deliver successful gaming applications for the museum sector that have a chance of being adopted by museum visitors (reaching new markets).

3. Channels

- Game environment
- Classroom
- Museum exhibition
- Social media channels

4. Customer Relationships

- Socially engaging
- Addictive brain training
- Viral
- Trusted (content for learning)

5. Revenue Streams

- Merchandising
- Freemium

(The basic version is for free. For additional features, editions, more possibilities for users to interact [more players], choose content, etc. you have to pay.)

- Selling the app to museums
- Governmental funding
- Philanthropic funding
- Corporate sponsorships

- Advertising
6. Key Resources
 - Metadata in Europeana
 - Content providers
 - Europeana Network
 - Game developers
 7. Key Activities
 - Marketing
 - Legal clearance
 - Manage/build partnerships/relationships with museums
 - Content aggregation/curation
 - Support users
 8. Key Partners
 - Game developers
 - Game producers
 - Museum experts/professionals
 9. Cost Structure
 - PR and marketing
 - Software development
 - User support
 - Merchandise

2.3.4.3 Value proposition and stakeholders

The focus of this business model lies – in this case as well – on the value proposition, as this is the reason why customers decide to have this product over another. It needs to be pointed out again that the online Memory Card Game is not an innovative product per se, as there are already a lot of memory games for children on the digital market; however, it offers some extra options which extend its value.

The “Memory match” game is considered to be valuable for the following stakeholders:

1. For **pre-school and elementary-aged children** the Memory Card Game offers an attractive and free educational app about the topic of natural history. The app market has become a significant one for children. A study has shown that over 80% of top-selling paid apps in the educational category of the iTunes Store target

children. From this number, 72% target preschool or elementary aged children.⁶ This shows that there is a general interest for this kind of apps, as especially **parents** search for applications with good and trusted content, combining a game with a learning experience. The Memory Card Game fulfils these conditions and the fact that it will be a freemium game makes it even more attractive on the app market.

The game can also be of added value for schools, as complementary teaching tool for **teachers** and as additional learning tools for **students**. However, there is the concern that it is extremely difficult to enter the classroom, as devices in general are primarily consumer and not institutional-focused, meaning that they will not be tailor-made for existing educational programmes.

Distribution, awareness and access are significant issues, therefore the Museum Card Game should not only target the school market, but rather the consumer market, as this is the way to assure a multiple use of this application in the classroom, at home or on the go.²⁵ The Museum Card Game is a good additional learning tool to practice the knowledge on natural history in a playful way, giving teachers also the opportunity to choose their own content for the game according to the topics dealt with in the classroom.

2. For children's museums, the Museum Card Game can be used as a collaborative tool while visiting the exhibition. For museum educators it can be very useful to use the app on borrowed devices from the museum in order to guide a group and at the same time to offer them some excitement and diversification in experiencing the exhibition. The other extension is that museum and gallery professionals or other professionals from institutions with exhibitions can use this app for their exhibitions, creating sets according to their exhibition collections and displaying the game on touch panels directly in the exhibition room. The additional information on the cards can include, for example, information about where the object is located in the room, exhibition or museum building.
3. The Museum Card Game is interesting for technology providers and game developers because they can promote their services in new growing markets (children, museums). Since 2009, the percentage of apps for children in general has risen; especially the toddler and preschool age category saw the greatest growth. Because the software developed within the Europeana Creative project will be licenced under an open GNU/GPL licence, they can get inspiration to create their

⁶ See Carly Shuler, "iLearn II: An Analysis of the Education Category on Apple's App Store", Joan Ganz Cooney Center, New York, January 2012, p. 3, available online at: <http://www.joanganzcooneycenter.org/publication/ilearn-ii-an-analysis-of-the-education-category-onapples-app-store/> accessed on August 27, 2014.

own applications and versions of apps and games; they can re-use the content-rich software for their own purposes; besides participating via the re-use of content rich software, they can also participate with hardware solutions (e.g., tablets).

2.3.4.4 Revenue streams

For the “Memory Match - natural history collection” memory card game were identified following business models taxonomy/revenue models for the re-use of public content for the Natural History Education Pilot:

1. **Crowdsourcing:** Crowdsourcing does not create revenue but rather value and a sense of community. In the Memory Card Game the users (parents, teachers, students, museum lecturers) can create a quiz from a predefined template for each specimen or tagged content to extend the memory game. Museums can also use this app for their exhibitions, creating sets according to their exhibition collections and displaying the game on touch panels directly in the exhibition room. To stimulate crowdsourcing activities for the application, competitions can be set up including winners’ packages. For example, if a player completes a certain collection or are the best player for a certain quiz, he or she can pick up a prize at the museum and or get free admission to the museum.
 - Strengths and weaknesses: This model empowers the end user to contribute to the application (e.g., design, scope) and to add information. However, the model relies on active user participation. For the Memory Card Game various schools and students from NMP’s network are engaged, but there is a challenge if this community can grow (virally) during the project period.
 - Short- and long-term viability: The success of the Memory Card Game is dependent on an active community of users that are enthusiastic about the product, want more and might even be willing to pay for premium services. It was decided that this business model should thus be followed up on the short term.
2. As with the previous application, revenue can be generated by offering the first version and deck of cards of the Memory Card Game for free, this is also in line with the open access requirement mentioned earlier. Additional versions or decks for the game can be purchased for a fixed prize afterwards, to help sustain the game after the project period (**freemium business model**). An example of such a freemium modelled card trading game is the recently released game “Hearthstone: Heroes of Warcraft” by Blizzard.
 - Strengths and weaknesses: The game anticipates users that like to collect natural history objects which can create an “addiction” for the users. By adding new sets to the game, the interest of the users in the game can be stimulated, so they purchase new versions or components to continue to collect things that are available in the game environment until a collection is complete.

- Short- and long-term viability: Offering more versions or chapters of the game requires more resources and especially more content. At least for the second chapter of the game, additional funding is needed to finance the development and programming, meaning that especially after the end of the project funding, new means have to be found to keep this project going.
- 3. **Projects and consulting:** Like the previous application, this game can also generate revenue by customising the app for other museums for children to use it for their exhibitions. Together with the museum and according to their exhibition collections, a new set of cards for the game is made and offered on touch panels that can be lent for visiting the exhibition. The app will create interactive elements in the exhibition. The costs of such a project could be covered by the budget of the museum or external (governmental) project funding. An additional way of covering these costs would be to ask for a financial contribution by the direct beneficiaries in form of a rental fee for tablets that can be used to navigate in the museum and to play the game.
- Strengths and weaknesses: For the target group of natural history fans that like to collect things it would be very interesting to be offered a card deck that covers natural history collections from all over Europe, adding unfamiliar species to what they already know. Considering the major budget cuts in Europe, it is difficult to rely on public funding either directly from museums or from governmental sources with the goal to improve accessibility of digital heritage.
- Short- and long-term viability: For the Pilot period this model is out of scope, but this can be explored as a model on the long term, to be repeated for other museums in either a standard service model offer or on a project basis. It is advised to start already within the project period to search for new funding opportunities, especially by building a network of interested museums with natural history collections that are willing to be part of the game.
- 4. **Merchandise:** While keeping the basic version of the card game free to use, the organisation can engage itself in business resulting in direct sales of additional goods. Because the card game is targeted at consumers and tries to create a community of fans and players, fan merchandising can be an interesting way to bind the community and generate revenue. An example is the hugely successful merchandise strategy of Rovio's "Angry Birds" game. For the Memory Card Game one can think of special deck holders, T-shirts, geological gadgets or plush natural history items like fossils.
- Strengths and weaknesses: A strong community-building element is needed. However, this cannot be the core business model for the game and relies heavily on an active fan community. Also, specific merchandising expertise in the team is needed which is currently not available.
- Short- and long-term viability: It is advised to explore this model on the long term, once a strong fan base has been created around the game.

5. **Philanthropic funding:** This is a frequently used method which could generate revenue to further develop the application. Revenue would mainly be generated from indirect beneficiaries (e.g., organisations, technology providers, companies, etc.) and also, if possible, from direct beneficiaries (e.g., teachers, families, gamers, etc.).
 - Strengths and weaknesses: This model is a very powerful way to bind your community of users and get direct support from them in the further development of the game. Short- and long-term viability: A every enthusiastic community of users is needed to be able to promote the game to donators. On the short term, this is not established yet, so it is advised that this is something for the long run to try out. As this model is highly dependent on the current economic climate, it was also noted that this model should not be considered as a standalone revenue source.
6. **Corporate sponsorships:** Support of the product by corporate members through money or know-how. It is also very useful to associate the product with well-known commercial partners that also target pre-school and elementary-aged children. This would lead to a higher visibility of the product and would attract more sponsors.
 - Strengths and weaknesses: This offers a powerful way for technology providers to enter a growing market with their existing software and/or hardware solutions, but it also requires that they meet the company's professional expectations, which will be high in the case of bigger brands like Apple or Microsoft; they may be lower for smaller technology companies.
 - Short- and long-term viability: It is advised to explore this model on the longer term if the product is mature enough to present it to corporate sponsors.
7. **Crowdfunding:** A donation-based crowdfunding model seems to be a suitable approach in this project. Especially collectors and fans of natural history topics may have an interest in supporting the further development of the game. At the same time, this means more control by the community, more feedback on the game and also direct feedback, if the game and the idea behind it are relevant to the targeted audience.
 - Strengths and weaknesses: The benefits for the community of fans that are enthusiastic about the game are high. They can influence the further development of the game and be part of the product.
 - Short- and long-term viability: It is advised to explore this model on the longer term if there is an established community to be targeted.
8. **Advertising:** Online advertising is widely spread and a good way of generating revenue. For this approach, the right partners have to be chosen. Serious advertising is needed to keep the quality of the application high; advertising partners that have the same customers as the application should be chosen (e.g., eLearning products, education products and offers, etc.).
 - Strengths and weaknesses: A proven model to generate revenue, although, if used in formal educational contexts, it is too commercially driven. As the main customer

- of the Memory Card Game is more broadly focused on consumers, this might not be a problem.
- Short- and long-term viability: It is advised that this model is considered on the longer term because it is important to choose the right (thematically close) and serious partners for this. However, it is advised to develop this network of partners during the project period.
 - 9. **Public–private partnership:** This model can be useful for the Memory Card Game as it can bring important new partners (e.g., Apple) and new resources, services and know-how. At the same time it can generate revenue (e.g., educational publishers, technology providers, etc.), and even reduce funding needs via indirect beneficiaries (e.g., technology providers).
 - Strengths and weaknesses: This is an opportunity to create new alliances and to get support from other key stakeholders. However, it is very important to define targets, tasks, duties and limits of this partnership from the very beginning, to assure a good outcome and a long-running collaboration.
 - Short- and long-term viability: It is advised to explore this model on the longer term if the product is mature enough to present it to potential private partners.
 - 10. **Selling audiences to businesses** is, again, a business model in which customer-related information is sold to data-mining agencies, but maybe also museum marketing departments around Europe. The advertising model is seen as supportive to the goals of the Memory Card Game.
 - Strengths and weaknesses: The model aims at a deeper knowledge of users or viewers which caters the increased needs of (public) organisations to develop content that interests their public most.
 - Short- and long-term viability: It is advised to explore this model on the longer term if the product is mature enough and the community is big enough for the marketing intelligence to become valuable.

2.3.4.5 Earning Models

From the business model canvas for the “Save the Species Card Game”, these were the values customers might be willing to pay for:

- winner’s package (badge and map);
- marketing know-how for museums;
- rented tablet for museums;
- brokerage fee for curators – discount;
- tour guides, tour agencies
- interactive elements for exhibitions.

Similar elements can be used for the Memory match game after modification. The game is distributed for free but can include in-game micro transactions as for additional special sets, premium content or functional extensions.

2.4 Pilot Evaluation

The final evaluation results of the Pilots will be delivered within WP6 at a later stage. This chapter summarizes the core findings until now. During the first year the evaluation focused with priority on the development process based on the adaptation of the agile Scrum development framework in order to improve the communication and workflow. The adapted agile Scrum development framework has shown its functionality after some adjustments in year one.

The main difficulties encountered during the development stages are related to the Europeana Portal search functions and the availability of relevant content. In order to improve the impediments the Europeana Foundation announced a content coordinator who improved the situation significantly. By the beginning of the Challenge phase a variety of content sets was available for re-use.

An important evaluation task was the UX testing compiled by WP6 which focused on the front end of the product. The execution of the testing was done in two steps, offline and online. The offline testing was realised in parallel in two physical labs from the Europeana Labs Network. The applied method was an adaptation mixed from the think-aloud protocol (TAP)⁷ and world cafe⁸. The combination of both methods allowed getting a broad feedback on the products. In the beginning the two methods needed certain modifications. The UX testing tasks were realized in working groups with three to four persons what made a loud thinking during the testing not feasible. Instead the participants solved a predefined task with the applications on their own and wrote down their experiences and perceptions on Post-its. After everyone has finished the testing the group discussed the experience at the working stations and documented their results on a prepared flipchart paper. The rotation of the participants allowed an enrichment of the feedback provided at each working station. The UX testing was focusing on six predefined usability indicators (Table 1). At the end of the development cycle a second testing was compiled by asking the same participants to test the final prototype online by applying the same principles like in the offline UX testing workshop and indicating their feedback through an online survey.

⁷ http://en.wikipedia.org/wiki/Think_aloud_protocol accessed on August 27, 2014

⁸ http://en.wikipedia.org/wiki/The_World_Caf%C3%A9 accessed on August 27, 2014

Table 1: Usability Indicator ⁹

Criteria	Explanation
<ul style="list-style-type: none"> • <i>Starting screen</i> 	<p>The test person has a positive first impression and is willing to start using the product. It is clearly visible what kind of actions can be initiated. The screen displays the purpose of the application and raises awareness on the value proposition.</p>
<ul style="list-style-type: none"> • <i>Accessibility</i> 	<p>The applications pricing is transparent. The test person can easily access the content. The user control and navigation matches the requirements off the application and its hardware. Important fields to fill in are labelled with terms that match the real world.</p>
<ul style="list-style-type: none"> • <i>Navigation</i> 	<p>The status within the application is visible and test persons are aware of it. The navigation is consistent and standardized. Test persons can recognize easily how to navigate to a desired destination. Links and buttons are described in a manner that allows test persons to identify the purpose clearly.</p>
<ul style="list-style-type: none"> • <i>Design & Layout</i> 	<p>The design follows aesthetic criteria, addresses the target audience and is consistent through the whole application. Relevant content is identifiable and displayed accordingly.</p>
<ul style="list-style-type: none"> • <i>Efficiency</i> 	<p>The application can be used by a broader audience than the target group. Expected objectives can be reached by the application.</p>

⁹ <http://www.nngroup.com/articles/ten-usability-heuristics> and <http://userium.com> accessed on August 27, 2014.

<ul style="list-style-type: none"> • <i>Help options</i> 	<p>During the use of the application the test person is provided with hints (e.g. error prevention), search and help options.</p>
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In case of the Natural History Pilot two prototypes have been developed. The Educational Adventure Game and the Memory Card Game have been tested by participants from the educational sector.

2.4.1 Adventure Game

In general the application was perceived as an attractive way to engage a broad range of users. Especially the design was appreciated by the testers. The navigation needs further improvement with special regards to the user awareness of where to go and how to move forward or backward between screens. For an educational purpose the used content would need more contextualisation. During the online testing the participants have been asked to indicate their attitude on specific questions with regards to potential business models (figure 33). One third of the 18 testers from the offline UX testing answered the survey (N=6).

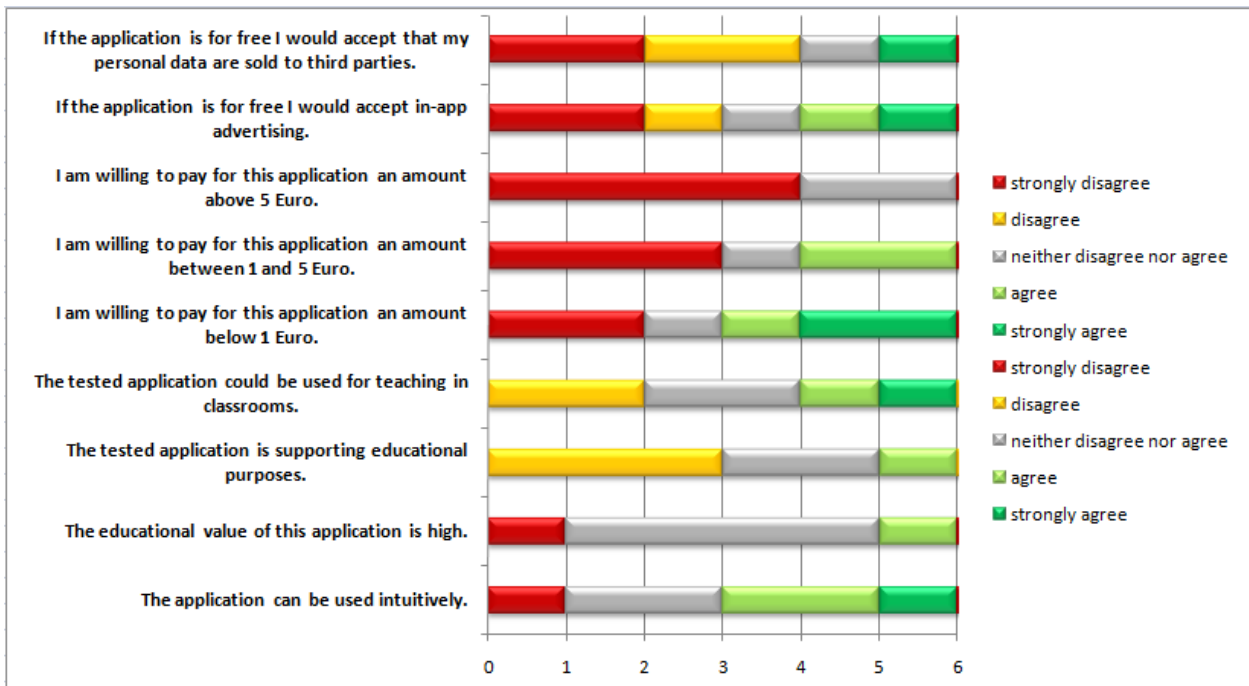


Fig. 30: Survey Results Educational Adventure Game

2.4.2 Memory Card Game

The memory card is a good option to draw attention to natural history in general. The application can be used by a broader audience than the target group. The testers gave the feedback that expected objectives can be reached by the application. After adjustments from the first UX testing the difficulty of the questions was experienced as appropriate by the testers. Like for the Educational Adventure Game the response in the online testing was N=6 (figure 34).

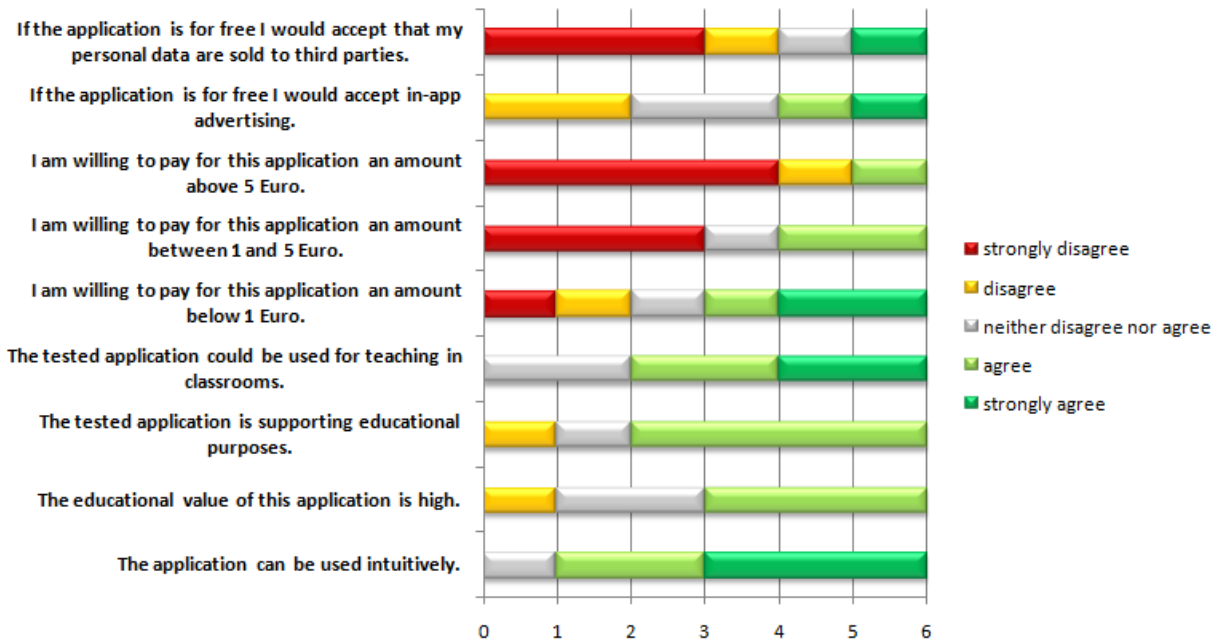


Fig. 31: Survey Results Educational Memory Card Game

3. Challenge for Natural History Education theme

3.1 Challenge Event

In order to engage creative industries to re-use digitised cultural heritage content Europeana Creative compiles five thematic Challenges in the field of Natural History Education, History Education, Social Networks, Tourism and Design. A customised communications plan was elaborated to promote the first Challenge Event (MS27), with a high focus on promoting the Pilots’ results alongside; plus Pilot was presented at several events including the Challenge by Jiří Frank.

The initial Challenge event was addressing the educational themes and started February 12, 2014. Interested participants had the chance to apply through the competition platform <http://ecreativeeducation2014.istart.org/> maintained by the Kauffman Foundation¹⁰ from Kansas City. For a successful submitting of the proposal the participants had to answer eight categories (c.f. table 2).

Table 2: Application Criteria Description

Application Criteria	Description
Project idea and applied dataset from the Europeana content repository or database	A description of the applicant’s project idea, delivery strategy and the proposed Europeana datasets to be used. ¹¹
Vision: innovative character of the project	The description of the vision and innovative character should describe in maximum 75 words the idea of the business planned and point out what differentiates the idea within the chosen marketplace.
Market potential	Applicants need to show that they have done research on the targeted market (ideally including a rough competitor analysis)

¹⁰ <http://www.kauffman.org/>. accessed on August 27, 2014.

¹¹ Depending on the development stage of the Content Re-use Framework and the available open access and copyright-cleared content in Europeana, the applied database can vary. In online consultancy sessions the applicants can clarify in advance what kind of content is available for the Challenge theme.

	and potential target audience.
Economic and financial viability of the project	Sustainability is one core element of the required business plan. The business plan does not have to take a commercial approach (e.g., a free-to-use educational platform would potentially be a viable idea) but it would need to show a “self-feeding” potential.
Potential social impact of the project in the community	Applicants shall describe what their business is going to change for the community of customers and how the idea engages people.
Feasibility of technical implementation of project idea	The application must elaborate how the business will be developed, what kinds of resources are already available and how missing ones will be acquired. The technical implementation must be feasible with the resources allocated.
Business model	The “Business Model Canvas” ¹² will be embedded in the application form. The applicants shall fill in this form to describe their business model in a brief way.
Short profile of the applicants	A one-pager which describes the expertise of the applicant/s in relation to the provided concept.

The application phase ended April 14th 2014 and the judging process started. The project deliverable “D5.3 - Challenge Entry Criteria, Selection Process and Prize”¹³ describes the application and judging criteria which have been applied for both Challenges. The jury consisting of eight jurors from the project consortium and external experts was shortlisting the five best applications of each theme afterwards.

The nominees have been invited to the final Challenge event in The Egg, Brussels on April 29th 2014. Here the participants had the chance to pitch their concepts in front of representatives

¹² <http://www.businessmodelgeneration.com/canvas>. Accessed on August 27, 2014.

¹³ http://pro.europeana.eu/documents/1538974/1601973/eCreative_D5.3_MFG_v1.0. Accessed on August 27, 2014.

from the creative industries and potential investors. At the end of this event the final winners of the Natural History Education and History Education theme have been announced.

3.2 Challenge Results

Overall 23 representatives from the creative industries applied for Challenge themes. While 21 of the submitted applications were addressing the History Education theme only two of the received applications were addressing the Natural History Education theme. Both applicants have been invited to Brussels.

BeHumboldt

Be Humboldt inspires the creative and active use of the mobile devices engaging young users in the discovery of their close environment and of inspiring stories about Science. It safely guides communication and social media to the interests and collection interchange, providing a social learning experience.

BeHumboldt wants to engage children in scientific discovering turning mobile devices into exploration tools. Interactive stories about real scientists like Humboldt will inspire activities and challenges. BeHumboldt is also a safe social media where kids can make their profile and showcase their captures, badges and digital collections with digital scrapbooking tools.

Pathway Authoring Tool for museums

The Pathway Authoring Tool for museums and Science centre is a web based tool for building complex web resources with a story like structure, empowering education and content experts at museums to make the most out of authoring, publishing and sharing technologies while using, re-using and re-mixing the world's high quality collections of open digital resources. The tool also aims to collect visitor data, enabling museums to make better decisions about visitors' preferences and needs.

The wealth of digital collections and the applications based on these are rarely embedded in personalised educational activities aimed at maximising the learning outcomes of museum visits. Our vision is to empower museum staff by providing them with a simple, but attractive authoring tool for designing educational activities based on open resources (e.g. from Europeana) that engage visitors in inquiry based activities inside and outside the walls of cultural institutions using their preferred mobile devices.

After the pitching session the jury selected the Pathway Authoring Tool for museums as the final winner.

With the regards to the use of the Europeana infrastructure it has to be mentioned that the Europeana Labs and the Content Re-use Framework (CRF) as well as the tools developed within the project all have been in beta stage that could not be integrated in the submitted

proposals. Independent from this point none of the applications or prototypes submitted made use of the Europeana API. The reasons for that varied some applicants have not been entirely sure what kind of content they wanted to integrate in their product and others required content that could be used offline within their product.

3.3 Assessment of Added Values for Creative Industries

At the time of writing, the assessment of the Pilot impact could not be finalised because the relevant indicators cannot be applied at this stage. Within the deliverable ‘D6.1 – Evaluation Strategy and Framework’ the Pilot impact evaluation is basing on 5 different criteria (c.f. table 3)

Table 3: Pilot Impact Evaluation Criteria

Impact Evaluation Criteria	Description
Number of contributors	Target group, take up and depth of involvement. For some of the Pilot theme the contribution by volunteers is mandatory based on the indicated business model (e.g. History Education and Social Networks).
Number of uptakes for the Challenges	The uptake of the Pilot concepts for the Challenges is addressing those applications that are building on the initial Pilot concepts / products.
User statistics	<p>The user statistics can provide important information about the impact of a Pilot. Such statistics can be:</p> <ul style="list-style-type: none"> o Number of downloads o Numbers of subscriptions o In-app purchases o Number of frequent users
Sustainability of the Pilot beyond the project duration	This category is addressing the successful acquisition of funding or further investments besides the SMEs who are developing the products. It should also include an assessment of progress against the business planning targets each Challenge winner is

	developing as part of their incubation support package.
Requests besides CCIs	The number of direct request from CCIs to project partners for cooperation or the development of related products.

Within the first year of the project Europeana Creative was challenged by certain difficulties which made it hard to provide a functional source code for the Challenge participants, this is why the number of uptakes cannot be measured so far. The same appears for user statistics and the sustainability of the Pilots. Given the fact that none of the Pilot products was released until now the user statistics and requests besides CCIs have to be evaluated at a later stage of the project.

4. Conclusion

The Natural History Education Pilot fulfils all its tasks. The main task was to demonstrate the effective collaboration between memory institutions and creative industries on re-using digitised natural history content published on the Europeana for creating valuable educational products. The Pilot used several innovative and new methods and strategies which were not used in similar EU funded projects yet and therefore the Pilot worked as a prototype and testing environment for this new approach. The innovative methods were used in all phases of the Pilot: the co-creation workshop for the product development planning and concept creation; the Agile SCRUM software development method for the development coordination, evaluation and tracking; business model canvas for the business models preparation, possibilities identification and evaluation; the UX methods for testing and evaluation; and the Challenge event with the spin-off project phase.

Several important lessons were learned: It is important to have a good balance for the achievable successful commercial products which will come from the collaboration between creative industries and memory institutions. This depends very much on the type of product and also the topic/theme. For the gaming industry it is important to implement a high level of fun, immersion and gaming aspects in balance with educational aspects and knowledge gained. The commercial sector can be very stringent in those criteria, which does not mean that the product cannot be very valuable. For having the product including high educational aspects as well as a high level of knowledge and details, this will usually be important for having third party funding from either projects, institutions or governments. If the product will be attractive and innovative enough, it has a good chance to get the attention for this funding. There is a good example for this case. The National Museum in Prague is now in the process of reconstructing the main exhibition building and preparing new exhibitions. When the Pilot products and concepts were presented to the exhibitions preparation board, they start discussing about considering investing certain parts of their budget to adapt the Pilot products for the prepared exhibitions. It will create a new collaboration with the creative industry for the code and products adaptation and will also bring new content to the Europeana portal. This case study will be also included in the final project documentation and can be a good inspiration for the external partners from the creative industry and memory institutions as well.

Another lesson learned pointed on the variable re-use of the content on Europeana depending or not on the Europeana API. In some cases it is not necessary to use the API or Europeana infrastructure for the re-use of resources, but the portal is still very valuable the promotion of the digitised cultural heritage content and in a way can be a mediator between the creative industry and the content provider / memory institution. Due to the visibility and accessibility of the content provider content on Europeana, this collaboration can be realized. The Europeana Creative project is a great example for this process.

The possibilities on how to re-use the digitised content by the creative industry are endless and the Pilot showed just two possible cases, but it proved that it is possible and valuable. Together with the results from other Pilots, which are improving the project workflow during the project as more experience in implementing new methods, strategies and processes is gained, the project is building a new valuable approach which is also related to the Horizon 2020 strategy. This

process is new for the creative industry as well as for the memory institutions, but will be important in near future together with the open access data and ongoing digitisation of collections.

At the moment It is difficult to estimate if and how the Pilot products will be successful on the market or re-used by other creative industries, but important is that these case studies were created and this innovative process started.