

# ENHANCING VISITORS' EXPERIENCE – A SERIOUS GAME FOR MUSEUM ENVIRONMENT

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## Abstract

In this paper we present the project of developing a digital educational game for the German Maritime Museum Bremerhaven (GMMB). The game is related to the main exhibit “Hanseatic Cog” and the medieval exhibition about “Hanseatic Times”. The goals of the project are not only to enhance museum visitors' experiences by making them aware of certain exhibits, stimulating them to explore the environment and offering them new information, but also to gather knowledge about integrating serious games beyond the limits of the private sphere.

Not only typical problems of serious games had to be solved, i.e. making the play an engaging and educational experience, but also specific demands of the museum regarding the time available for the visit, the flow and number of visitors, information displayed and duration of the game had to be taken in to consideration.

In order to increase “fun” during the play, we chose an explorative game type of “learning by acting” (action learning). In the role of a sailor and trader, the player has to apply his acquired knowledge by acting in the game rather than just answering simple quiz questions. However, sometimes quizzes were necessary during certain parts of the play in order to make information explicit and faster to be grasped.

In several development cycles, game prototypes were tested by school children also inside the museum and optimized according to the evaluation results. The results of the usability tests showed that an educational game for a museum context needs to be highly self-explaining, using clear instructions and clear metaphors. After testing the final prototype, we are confident that it engages visitors for the exhibition topic and improves learning effects.

Keywords: Educational game, game-based learning, museum game

## 1 INTRODUCTION

“Fun is one of the important motivators for learning. That’s why game-based learning is discussed as an effective approach to teaching and learning.” [1, p. 106f] This statement of Marc Prensky, internationally acclaimed promoter of game-based learning, is a growing reality especially for the young generation, which is socialised with the internet and digital games. Today’s “Net Generation,” or “digital natives,” as van Eck calls them, “who have become disengaged with traditional instruction”, is one factor responsible for the changed image of educational games. [2, p. 17]

While prejudices and scepticism against using games for education are decreasing, the use of games beyond the private sphere in contexts like museums for cultural heritage is not yet generally accepted. With the project described in this paper, we wanted to investigate benefits and problems of developing a serious game to be integrated in a museum exhibition.

Traditionally, the purpose of a museum goes beyond only providing information. Museums are places of exploration, which stimulate people’s minds with their exhibits. They present physically, what books show only on paper. In many museums, however, interaction with the visitor is a one-way communication. In order to preserve ancient exhibits, museums impose very strict rules of behaviour

on their visitors, including the most popular one: "do not touch!". Therefore, in many cases, visitors have a passive role and no possibility to "respond". That is one reason why museums are constantly trying to improve their communication with visitors. Interactive exhibits are one way museums found to enable visitors to act and to explore exhibits actively. As they inspire and provoke exploration, interactive exhibits are entertaining, and at the same time, they increase the visitor's engagement and thus the learning effects. Responding adequately to the visitor's actions, they support a learning-by-acting behaviour. Challenge and feedback, some of the key characteristics of games, positively influence motivation for learning, as Malone and Lepper have found out. [3] In contrast to mechanical interactive exhibits, digital games can place exhibits in a context. They can tell stories, e.g. about how exhibits have been used in the past, and create a meaningful interaction between visitor and virtual exhibit. Through games, visitors can experience the former environment and functions of exhibits. He/she can interact with the exhibit without the risk of destroying valuable objects.

While having the potential of enhancing the visitors' experience, multimedia devices in museums, however, hold also the potential of distracting visitors from paying attention to the actual artefacts. This problem is especially evident when visitors spend more time looking at screens than at the exhibits, as frequently occurs with mobile tour guides or collaborative educational games based on handheld devices (see e.g. [4]). This competition for the visitors' attention should be avoided. Although, the success of a game can be measured by the time spent on it, or the number of times players want to repeat playing, there must be a balance between the game and the environments where the game is inserted. The game should rather provoke visitor's curiosity towards the exhibition.

The task of developing a game for a museum environment has to cope with the contradictory demands of being engaging enough for the visitor's learning motivation, but on the other hand not taking too much of his visiting time. In a project of master students of the Digital Media study program at the University of Applied Sciences Bremerhaven, we tried to master this challenge when developing a digital educational game for the German Maritime Museum Bremerhaven (GMMB) related to the main exhibit "Hanseatic Cog". A stationary solution has been developed with the game running in a kiosk, which is supposed to be integrated in the medieval exhibition about "Hanseatic Times" presented in the GMMB.

The Hanseatic Cog, a medieval boat, had been found on the ground of the river Weser in Bremen, and it has been restored and conserved by the museum. Visitors can go around this huge exhibit and view it from different floors, but they are not allowed to touch it, and of course, they cannot interactively explore how it works. Therefore, the idea of the project was to apply interactive multimedia for presenting a virtual version of the cog in its medieval context. A storyline was developed around this historic setting, engaging the visitor to explore the sailing facilities of the cog and its use for trading goods between the Hanseatic cities.

In the following lines, we describe the main challenges of the project, ranging from the requirement of enhancing the visitors' experiences without distracting them from the exhibits, to the conflicting issues of developing an engaging learning game with limited play time.

## **2 MAIN ISSUES OF SERIOUS GAMES IN MUSEUMS**

Among many others, the value of a museum for a society regards not only preserving the memory of a civilization, but also educating and raising awareness about the culture of a nation. Museums are considered as public accessible places and a close and trusted way of reaching the past. At the Anne Frank's House, in Amsterdam - Netherlands, for example, visitors have the chance to learn a bit about Anne Frank's life. They can go through the hall, pass by the rooms, see her and her family's objects. This experience stimulates individuals to think about how was living there and what were their feelings and thoughts. Another example is the GMMB. There, visitors cannot only see parts of real ships, but also even get inside a submarine. Both, the Anne Frank's House and the GMMB give visitors the opportunity to be in touch with concrete and physical pieces of memory. This memory has to be preserved. However, usually museums are limited to only showing static objects and artefacts. They cannot show them in use or how they worked in their historic contexts. At Anne Frank's House Museum, it is not possible to lay on her bed, touch her objects and stay overnight, for example. In the same way, in the German Maritime Museum, it is unthinkable to go for a ride in the submarine. Even if possible, the complete notion of living during the Nazi persecution, or being in a war under the water would not be realizable. Those limitations are easy to understand and those facts will probably never change, but this gap can be diminished with the use of multimedia technology, especially interactive serious games for museums.

Museums have already a long tradition in including technology within their exhibitions, but still they are not very open to digital games. We claim, however, that museums are one of the most suitable places for educational games. On one hand, by seeing the real artefacts, visitors get a notion of space, size and form. They can smell and sometimes even touch objects. On the other hand, by playing, individuals can have another kind of experience. When acting within the game world, visitors can have a better comprehension of how those artefacts worked, and of the cultural context to which they belonged. "...when we play, we explore the possibility space of a set of rules – we learn to understand and value a game's meaning. Video games make arguments about how social or cultural systems work in the world - or how they could work, or don't work." [5, p.136]

Of course, due to the restrictions of the digital medium and the designers' construction of reality with the means of this medium, games are also limited. No matter if the game is implemented on a handheld device or a stationary computer, the designer is restricted to buttons, screens, speakers, capacity of processing and so on. Moreover, the "reality" has to be algorithmically interpreted in a way to fit those devices. The restricted means of interpretation and encapsulation are not adequate to present the full quality of the real artefact, but they can support and contextualize their concept. At this point, the potential of multimedia games becomes evident. They can work as interactive texts, which explain concepts, but are not capable of replacing the weight of the real artefacts.

An advantage of having games inside museums and side by side with the historical objects is that individuals can do real-time comparison and interpretation. This is especially valuable for young visitors like school classes, for whom a museum visit means an informal learning activity. It is important to make clear that digital games should not replace textual information, or decrease their amount. But they should be integrated as a complement for the whole experience, in which their contribution is to support the comprehension of the role the artefacts had in the past. On the other hand, the real artefact prevents misinterpretations which the virtual artefact represented in the game may cause. In the end, the result is a very profitable combination between digital games and traditional museum exhibitions.

In order to profit from the potential of adding complementary value to an exhibition object without doubling the exhibition content, a close cooperation with the museum is necessary. Museum experts have to provide the game designers with information about interesting aspects of the exhibition object to be explored and experienced when playing the game. The challenge for the game designers then is to create a meaningful story related to these learning objectives, and to add competition and interactive game effects, which engage the players and make it fun to play.

As the museum experts are not only consultants for the game developers but also stakeholders of the project, their further requirements have to be considered especially regarding location of the game in the exhibition, limitation of sound and audio effects, authenticity of the game content and duration of the game play. When the museum demanded to have a limited play time of five minutes in the case of our game, it was a hard surprise for the game developers, who were used to games with unlimited play time, many difficulty levels and challenges for the players.

Another problem arises from the typical trial-and-error behaviour of museum visitors. A quantitative study by Fleck et al. [6] has shown, that a typical museum visitor spends 1-2 minutes at a museum object. During this time, labels and instructions for interactive exhibits are usually not read. Interactive exhibits are tried out directly and people just refer to the instructions if they fail. In our project we could observe the same behaviour when testing the first game prototype. From this, it follows that a learning game in a museum has to avoid long instructions, and it has to be intuitive and easy to use. This challenges especially the user interface designers, who have to create self-explanatory metaphors and guidance for the graphical user interface. Avoiding long instructions without reducing the learning potential was the most challenging demand in our project, when developing a completely reviewed game prototype after the first usability tests.

### **3 THE GAME "HANSE 1380" – INTEGRATING A SERIOUS GAME IN A MUSEUM CONTEXT**

#### **3.1 Base the game on relevant learning objectives and historic facts**

Developing an educational game has to be based on well defined learning objectives. In contrast to just developing an entertaining game, it should be clear before starting to create the game mechanics and story, which learning effects the player should achieve while playing the game.

As the game of our project should be integrated in the exhibition about the Hanseatic Cog of the GMMB, one of the main objectives was to let the visitor explore the cog in its former context. But what does this mean concretely? To clarify the learning objectives in detail, the advice of the museum's exhibition expert was needed in order to understand the main characteristics of the cog, especially those which could not be explored with the exhibited old cog in the museum, and for deciding about the priority of the game's learning objectives. According to his advices, the game finally was based on the following learning objectives: "experience the functions of rudder, capstan and sail of a cog", "know how to navigate with a boat in medieval times without compass and sea charts", "understand the use of the Hanse cog as a trading ship" and "get to know some important Hanseatic cities and trading routes of the Hanseatic League".

We used different possibilities of integrating learning objectives into the game: Some relevant information was presented as text or audio text, especially when narrating the game story. Parts of the learning content were integrated in game rules like "use landmarks in order to navigate" or "adjust the sail by using the capstan". Other parts were implemented with special events requiring an adequate reaction of the player, like "when storm is coming, the sailor has to look for a protecting harbour and anchor the boat". Some learning objectives were also transported via the feedback of puzzles questions.

As serious games for museums have not only to be based on meaningful learning objectives, but also on true historic facts, an intensive historic research was done in the museum library following the recommendations of the museum expert. On one hand, the game content had to be researched carefully in order to present the cog in a realistic historic context. On the other hand, elements presented on the graphical user interface like old Hanseatic maps, the shape of the cog and the former view of Hanseatic cities had to correspond to the ancient environment and therefore should be based on well researched facts. For example, the cog cannot be presented with two sails, as its characteristic is to have only one sail. Compasses cannot appear in the game, because they were not yet invented at that time. Moreover, the design of the Hanseatic cities, their churches and houses have to refer to the views of medieval times, not to the actual ones.

### **3.2 Make the game engaging**

As the visitor was supposed to experience the learning objectives, we chose an explorative game type of "learning by acting" (action learning). In the role of a sailor and trader, the player has to act in the game rather than just answering simple quiz questions. In a sailing simulation with wind from changing directions, he has to sail the cog to one of the Hanseatic cities using sail and rudder. This requires a concentrated interaction with the game system in order to reach the goal successfully. Besides interaction and a clear goal, also challenge is needed to engage the player. For the sailing scenario it was obvious that challenge could be added to the game by having a sort of sailing race. For a single player game like the one in our project, this was not a race against other players, but a race against time. The advantage of using a timer was not only to keep the required time limit for the duration of the game, but also teach about the duration of a trading season during hanseatic times.

Some of the learning effects could be integrated in this scenario by adding further challenges during sailing like storm, cliffs, pirates etc. The player had to react adequately like in former times, by sailing near the coast, following certain landmarks along the route etc. While these interactive experiences increased the players' enjoyment and learning success at the same time, this was not the case with pure textual information provided to the player in order to explain the use of the controls, the sense of the landmarks and other game elements. Playtests with the first game prototypes showed certain click-and-go behaviours of the players without understanding their actions. Information, which was just provided as text, but not really needed to successfully interact in the game, was not perceived by the players. In consequence, a revised prototype was developed with some important changes: Spoken text was integrated additionally to support the written text, and click-and-go is disabled, until important spoken texts are finished. For certain quiz questions, the game mechanics ask the player to reassure, if his decision was correct. However, Trial-and-error clicks cannot completely be avoided, but are very soon punished with "game over". While achieving a much higher learning success, especially the integrated spoken text has also stimulating effects for the player.

To improve the educational capabilities of the game and to engage the player, a kiosk resembling the cog was built. Also, the joystick controls are miniature models of capstan and rudder similar to the facilities used to sail the real medieval cog. In this way, the mental mapping of the control to its corresponding function should be supported and give the player an impression how these instruments looked like in former times. This cog-like terminal design invites visitors to use the terminal and

creates a more engaging atmosphere, which is additionally supported through a touchscreen used for user-input (see fig. 1).

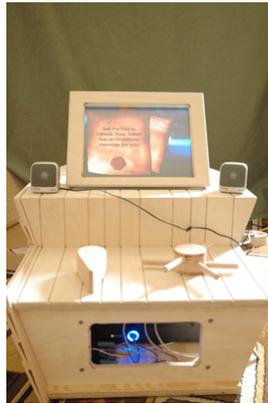


Figure 1: Cog-like kiosk and controls of the game “Hanse 1380”

Last but not least, the player can be engaged through an attractive design of the user interface, as well as through characters guiding through the game story and giving hints. A well designed, intuitive user interface is also very important in order to make the game self-explanatory and easy to use (see 3.4).

### 3.3 Limit play time

As mentioned already, one strict requirement of the GMMB was to limit the maximal amount of play time to five minutes. This limitation is an evident and easy to understand requirement for a public place, which contains not only valuable objects of cultural heritage, but receives also many visitors per day. In such an environment, a new-technology-based game should not compete with old artefacts. It should not distract the visitor from the antique exhibits. Rather it should motivate him/her to apply knowledge from the exhibition in the game, or – if playing before visiting the exhibition – it should motivate him/her to look more carefully at certain parts of the exhibition. For sure, the five-minutes-limit was accepted by the game developers, even if it was an unexpected requirement for most of them. However, it was a hard challenge to limit the play time without reducing the player’s experience and learning effects too much. A solution for this was found in developing independent game modules with a maximum of five minutes play time each. According to the game concept, at least three modules should be developed, allowing the visitor to select one of them depending on his or her interests.

One module of the game consists of a sort of sailing tutorial, where the player learns to sail the virtual version of the cog using the rudder and capstan controls. In a second module the player should apply his or her knowledge about sailing and navigating in medieval times without using compasses and sea charts. As these instruments did not yet exist, he has to find orientation with the help of landmarks. Another module with trading scenarios in the Hanseatic cities is not yet implemented. Here the player should experience trading goods among the hanseatic cities etc.

Due to its modular architecture, the game can easily be extended to a version with several modules for different learning objectives. The exhibition version however, should only consist of one module, while an extended multi-module version could be used either in the pedagogy room of the museum or at school in order to prepare for the museum visit or reinforce knowledge about the exhibition’s topic after the visit.

### 3.4 Make the game self-explanatory

One big challenge faced during the game development was the design of the user interface. For a game to be placed in a museum exhibition, an intuitive user interface as self-explanatory as possible is required, since it should be possible to play without any kind of external advice or help. In order to achieve this goal, a lot of changes were made as a result of the usability tests. The sailing simulation of the first prototype was difficult to manage by our target group. This was basically due to some graphic elements, which were not well designed, so that their functionality was not clear and it was hard to understand the concept behind them.

For example, in the first game version we chose to have the passing time represented with small time glasses (as you can see in fig. 2, item 2), because those objects were in reality used in the middle ages to count the time. In the game, the sand clocks were used to represent the months taken by the Hanseatic cog to reach most of the hanseatic cities. The problem was that sand clocks count actually minutes or hours, not months. Additionally, as some trips took up to nine months of travelling, nine sand clocks were shown on the screen increasing the amount of interface elements and confusing the player, who could not grasp all this information. That was why we decided to replace the sand clocks with a simple minutes count-down (as you can see on fig 3, item 2).



Figure 2: User interface of first prototype

Likewise the representation of the wind was changed due to misunderstandings. In the first prototype (fig. 2, item 3), it was represented as a single cloud located at the bottom of the screen, which blew air in 360 degrees. Most of our test groups were not able to understand both the graphic representation and the functionality of the wind. It was hard for them to comprehend that, in order to sail, the wind has to blow in the opposite direction to the sail. They were not able to make the connection between both. To solve this problem, we had the idea of placing the wind in eight different positions on the screen and thus making it more obvious to which side the sail had to be rotated in order to move with the boat. The sail must be adjusted to the opposite direction to where the cloud is located (as you can see on fig. 2, item 3).



Figure 3: User interface of second prototype

Having the screen too overcharged with information and design elements, we opted for showing information only, when it is necessary, that means when it is needed for the actual interaction. For this purpose, we decided to replace the "water level bar" (fig. 2, item 5) of the first version, which represented the amount of water in the boat, with an auto-hide menu (fig. 3, item 5), which appears only when the boat hits the coast or is in a storm. Another issue, in the first version, was the representation of sailing landmarks represented with two pictures, one showing the landmark the player passed, and the other one showing the next landmark he/she should pass (fig. 2, item 4). Having two landmark pictures at the same time was hard to grasp by the test users. That's why we changed the presentation to only one picture, showing just the landmark the player should head for.

All these improvements, such as taking out unnecessary elements, improving graphic representations and displaying information only when necessary, made the interface faster and easier to understand.

## **4 MAIN RESULTS OF THE PROJECT AND CONCLUSION**

Many were the challenges during the development phase ranging from adding a game-terminal within the exhibition, to designing a game flexible enough to provide additional value for visitors with different preconditions and at different phases of their visit.

In several development cycles, game prototypes were developed, tested by school children and optimized according to the evaluation results. The four usability and playability tests we had with school classes showed that an educational game for a museum context needs to be highly self-explaining, using clear instructions and clear metaphors. Mastering the main challenge of avoiding just trial-and-error reactions of the players, with the final prototype we are confident of not only enhancing the experience of visitors, but also increasing learning success.

We are convinced that museums can profit a lot from the interactive potential of digital media. Applying highly interactive multimedia technologies offers additional benefits in presenting and visualizing certain aspects and interrelations of exhibits, e.g. let the visitor have active experiences with a virtual copy of the related museum artefacts. In this sense, educational games go far beyond only displaying information. They are an educational tool engaging individuals to apply knowledge in an informal and entertaining way. The possibility to interact with concepts and representations is one of the main reasons why technology is suitable for museums. This potentiality can be greatly increased if the software is supported by the hardware, since body movements also take an active role in the learning process. This is one of the main advantages of having games associated with customized kiosks. In the game Hanse 1380, the player has the opportunity to sail the cog using mini representations of rudder and capstan, the main sailing tools of the boat. By touching these controls and experimenting with them, the player has a much more effective notion of how they worked, of their restrictions and peculiarities.

As shown in our project, a museum game has to be different from a game to be played at home. At home, the player is comfortable and has time to learn and explore the game world and all its features. Having unlimited time and several open goals seem to be desirable characteristics used in many successful games. In contrast, the structure of a museum game, which should stimulate the visitor exploring the exhibition, rather than spending too much time with gaming, has to be more restricted and simple, guiding the player through the game story and action. Almost no time should be lost by the player to understand the interface or the use of the controls. Designers should take a humble attitude towards the museum and be aware that the game takes a secondary role in the whole setting. This does not mean to create a boring game which does not engage the players, but it means to consider the real purpose of the institution where the game is placed and be aware of limitations of visitors, games and museums. The difficulty here is to find the right balance and produce a good result in the end.

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