

Technology based paper

Topical area: e-Learning, Training and Edutainment

The Middle-Rhine Eduventure Project – on the way to a new technology enhanced learning approach

***A mobile adventure learning game for pupils by the example of the UNESCO cultural heritage
Middle-Rhine valley in Germany***

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The pilot project “Middle-Rhine Eduventure” aims to exploit Augmented Reality (AR) and Virtual Reality (VR) to make young adults acquainted with history and culture of the Middle-Rhine Valley. An EDUVENTURE (integrating education and adventure) will be developed and tested as a proof-of-concept for a new way of learning within a mobile adventure game. The Eduventure approach pedagogically understands learning as self-guided, situated, mobile and game-based learning and considers important aspects of pedagogical game theory. Our pilot project focuses especially on the pedagogical relevance of AR and VR to foster learning as active knowledge acquirement of mobile persons, either acting in situ or online in a virtual environment.

Scientific interest

The phenomenon Play has inspired philosophers and educators for centuries. Already Plato stated that all people should "play the noblest games and be of another mind from what they are at present." In the scientific discussion of the last decades many authors did research on the relevance of play and games for human development, culture and learning (cp. Huizinga, 1938; Piaget, 1962; Sutton-Smith, 1979, 1980, 1986). For instance Johan Huizinga (1938) defined play as a vehicle for creating culture, going beyond the bounds of all biological activity. And Jean Piaget (1962) saw play as the vehicle through which children interact with their environment and construct their knowledge. Sutton-Smith (1979) extended Piaget's view on play and focussed play in the context of cultural development. Although presently no common definition of play exists, it is widely considered to be important to human development and learning.

Meanwhile computers became an important part of our work and daily life routine. Computer and video games have become a common leisure activity for children, teenagers and young adults and are part of the youth culture (cp. Griffiths, 1999; Anderson and Bushman, 2001). They are attractive to young people and have got a high motivational capability. Thus computer games in general represent an obvious possibility to initiate learning processes.

In the last years new innovative technologies like Virtual Reality (VR) and Augmented Reality (AR) emerged, which promise further possibilities for more realistic gaming (and learning) experiences. Additionally the development of efficient mobile computers point to the opportunity to design educational games for blended learning scenarios. “With the recent advances in mobile networking, context-aware computing, and sensor-based computing, researchers and game designers are able to explore the potential of combining these new technologies to develop mobile, context-aware, augmented reality multiplayer games.” (Wu et al. 2004, page 55).

Objectives

In this context the question arises if and to what extent computer games and the deployment of these new technologies can engage young people to work towards educational objectives. To explore this we initiated the pilot project ‘Middle-Rhine Eduventure’.

The project aims on the design of an **Eduventure** as a new way of technology enhanced learning. Eduventure is a concept which integrates education and adventure within a game based blended learning approach. A prototype of the Eduventure will be implemented and tested as a proof-of-concept. Thereby both the pedagogical potential of the Eduventure approach and the deployed technologies are of interest. The project especially deals with the question of the pedagogical impact of AR and VR to foster learning as active knowledge acquirement of mobile persons, acting either in situ, i.e. in an existing (augmented) historical site, or online in a virtual environment.

Concerning the content the project has got the objective to make young adults acquainted with the Middle-Rhine Valley – focussing on historico-cultural knowledge and insights.

Technological base

The Eduventure requires both stationary and mobile computer devices in order to be completely played. An online game is a central part of the Eduventure. It doesn’t require special hardware. Common state-of-the-art desktop PCs are suitable. In order to play the game an internet access to the game server is needed. For the implementation of the prototype and the intended proof-of-concept an existing game engine, which can legally be modified, is used to model the role based adventure game. The modification of a game with a similar structure does require less effort than the adaptation of a ‘blank’ 3D engine to the requirements of the Eduventure. Thus the selected engine provides the possibility to model different roles with their attributes and to develop a role at playtime. The virtual world to be created mainly consists of many different inner rooms of the castle Marksburg¹ and additionally of an outer space. Interaction in the game is prevalingly realized via dialogues, where the engine offers suitable possibilities. Game play and content are realized by scripts, which are specifically written for the game engine. A realistic 3D model of the Marksburg from another project as well as specially designed 3D objects will be integrated for an authentic context of the game.

¹ The Marksburg was chosen, because the castle is located in the Middle-Rhine valley near to the University of Koblenz and to potential school partners for the evaluation. Moreover it is in good conditions and is visited by many tourists every year.

The augmented game episodes in presence mode require tracking the player's position in a room to fit in computer graphics in real time. Therefore non-stationary markers, which are put up in certain rooms, have to be recognized correctly. Moreover game objects, like virtual characters or artefacts, have to fade in simultaneously. For the proof-of-concept a laptop capable to process AR in real time is used. The laptop is fitted with a webcam for the positioning and the display of the original room. With the help of the ARToolKit² the game objects are inserted into the camera picture. For the proof-of-concept no network connection is needed, because the information of the online game activities is downloaded to the test device. In the course of further development networked mobile devices are foreseen to extent the dynamic of the game scenario.

Pedagogical assumptions

The Eduventure approach pedagogically considers learning as self-guided, situated and game-based. One should learn **self-guided**, as activity is engaged by inducing intrinsic motivation of the learner to voluntarily play the game and to work on the inherent tasks of the game play. Intrinsic motivation is a relevant prerequisite for elaborated learning processes (cp. Friedrich & Mandl, 1997). The player has got full control on his own gaming activities. He can decide himself on the time and the effort he wants to spend. Neither the completion nor the results of his game are subject of school grades, although he receives a personalized feedback by the system for motivational reasons.

The constructivist concept of **situated learning** stresses learning in realistic and authentic contexts (cp. Collins, Brown & Newman, 1989) which are relevant for the learner and the domain of learning. Learning is considered as an active acquisition of knowledge and application on realistic problems, whereby multiple contexts are of importance to support flexible transfer of knowledge (cp. Bransford, Brown & Cocking, 2000). Knowledge should be applicable in different situations on different problems. Especially if games are utilized for learning purposes transfer of acquired knowledge or strategies is a major problem (Fritz, 1997).

Learning should take place within a **game-based** scenario. Although presently no common definition of play exists, it is widely considered to be important to human development and learning. Some authors doubt the possibility to utilize playing as an instructional mean for learning (cp. Flitner, 1992; Fritz, 1993). They state that learning is not an inherent feature of playing games. Although children would obviously learn whilst playing, they would do it in an informal matter. It is argued that a play is consciously not tied to any learning intentions. Moreover it aims on creating the player's own structures instead of reproducing externally given structures (cp. Piaget, 1962).

² ARToolKit is an open source vision tracking library that enables the easy development of a wide range of Augmented Reality applications. Online: <http://www.hitl.washington.edu/artoolkit/>

Concept

Domain

The story is located at the Marksburg, a medieval castle from the 12th century in the UNESCO cultural heritage Middle-Rhine valley in Germany. From content perspective the Eduventure aims on historico-cultural knowledge of the Middle-Rhine valley in general and of the Marksburg in special.

Target audience

The target audience of the concept are young adults in schools up from an age of 14 years. The restriction towards the age is necessary due to the skills which are required to play the game in a sensible way for learning. Also adults are addressed, as computer games are increasingly used by people beyond their twenties. Furthermore tourists, especially families, who visit the Middle-Rhine valley, are considered as potential users.

Pedagogical objectives

Players should gain fundamental historico-cultural knowledge in the context of the Marksburg in special and the Middle-Rhine valley in general. Particular of interest is the time of the thirty years war in Europe (1618-48) and especially the Franco-Swedish period.

Learners are supposed to gain

- a deeper understanding of important facts and events, their impact on historico-cultural development and their enduring relevance for the presence,
- an impression of the architecture of the Marksburg as a typical medieval castle and
- knowledge on important aspects of post-medieval life.

Especially pupils' interest and learning efforts towards historico-cultural knowledge in school teaching should be stimulated.

Learning by gaming

As learning is not inherent in playing games, the Eduventure approach concentrates on offering multiple occasions for the self-regulated and situated learning of the players. Thus the motivational capability of games in general and especially of computer games is utilized. The concept is oriented on features that contribute to motivation (cp. Becta, 2001). The whole story is complex enough to preserve some uncertainty for the player. The goals of the game scenario (see 'Game scenario') are challenging but achievable, and should require active participation of the player in the game scenario. In order to sustain motivation VR and AR, combined with context-aware mobile gaming sequences, should supply realistic ambience information to create immersive experiences. Instant feedback to the player is another important mean to sustain motivation (Prensky, 2001).

In the context of game based learning a transfer of knowledge in both directions, either from daily life into the virtual world and vice versa, is generally uncertain. Empiric evidence exists that transfer from the real world into the virtual game world more often occurs (cp. Fritz et al., 1997; Esser & Witting, 1997). Concerning possible learning results of playing complex games empirical data indicate that achievement and training of competences – mainly problem-solving – is in particular important (cp. Kraam-Aulenbach, 1997, 1999). Due to these assumptions the learning occasions are embedded in an appealing story. Not mainly acquisition of facts, but a deeper understanding of contexts, is emphasized. Pupils can explore relevant facts and aspects in a realistic context, both towards location and history. Three tasks (problems) are incorporated in the story of the prototype, which are not just an add-on to the story but a central part for its further development. Learning as well as developing of the story is pushed by problems. The player has to apply authentic knowledge to solve the problems and to conclude the game. Self directed acquisition of knowledge, available within or outside the game (e.g. libraries, persons, internet), should be initiated and fostered by the game play.



Figure 1: Photography of the Great Banqueting Hall at the Marksburg.



Figure 2: Screenshot from the virtual model of the Great Banqueting Hall at the Marksburg [from a slightly different perspective].

To foster situated learning processes the game play adopts authentic historical sites and incidents and the roles are designed in a realistic manner, i.e. towards their social status or specific attributes of their medieval role models. Learners can experience a role in a realistic and authentic setting and at the same time learn about the setting itself. By choosing different roles they can experience cultural history from multiple, but realistic perspectives. They can develop intuitive skills at coping in that environment (cp. Khan, 2002).

The game is designed in dual mode as blended gaming and learning. The game is split in episodes in virtual mode and in presence mode. The virtual episode consists of a more or less conventional role based adventure game with an uncertain ending.

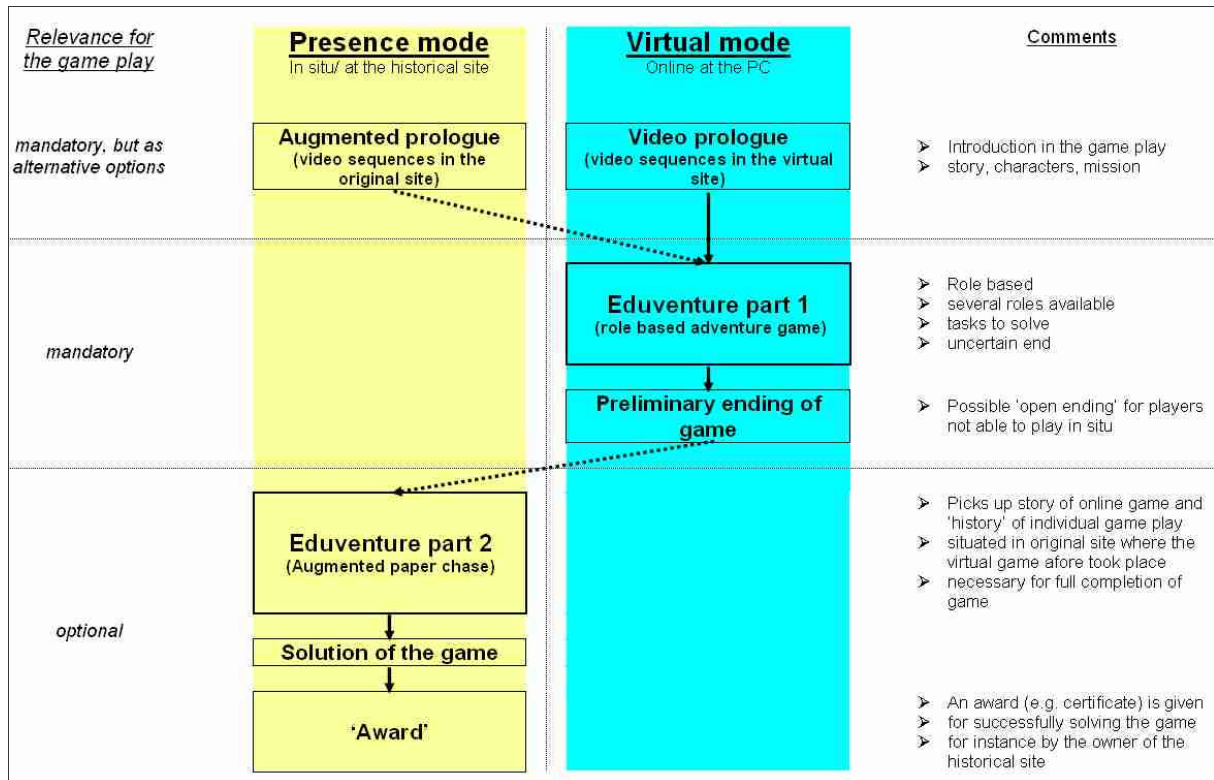


Figure 3: Dual mode structure of the Eduventure

Online episodes (virtual reality) alternate with in situ real world episodes at the historical site in the Middle-Rhine valley, which are partly augmented and technologically supported by AR and mobile, context-aware computing. Especially the deployment of AR should foster a structural linking of both real world and game world. By structural linking FRITZ (1997) described a process wherein elements of the one world (e.g. game world) must transform to their counterparts in the other world (e.g. reality) to allow impact on the person's actions. By combining elements of real and virtual world new immersive ways of accessing historical knowledge of the past emerge. Thus one not only learns facts of the Marksburg and related historical events, but can 'experience' them interactively on his own.

Playing a complex game and solving complex problems in a self-directed manner means that players must own problem-solving skills and self regulation skills to some extent already (cp. Kraam-Aulenbach , 1999; Subrahmanyam et al., 2001). RANDERL et al. (1992) stated that debriefing can affect the effectiveness of games in encouraging learning. As the Eduventure project mainly addresses school pupils, teachers could act as mediators of their students' learning processes. They could motivate, prepare and debrief the game activities of their pupils as an additional option in the context of their school teaching (e.g. history).

The story is central for the success of the Eduventure towards its pedagogical impact. The story promotes the tasks and the authentic context which are central for the intended self directed learning. Furthermore it justifies the necessity for gaming in a Blended Mode and deploying the different technologies, especially for the augmented paper chase (Eduventure part 2) on the Marksburg.

Story and Game scenario

Framework plot

The story starts in the presence. The player reads a job offer in the news paper that looks for a brave and physical fit volunteer for a special mission. In case of success an extraordinary award is promised. He responds to the advertisement and meets two weird scientists who tell him their very special problem. They invented a time machine and just successfully performed some initial tests, as unfortunately their doddery charwoman wiped on a false button of the machine. By that she accidentally activated the time machine and disappeared in the past. The scientists admit that to their very much embarrassment they have no idea of the time period in which the charwoman was sent. Only the location is quite clear: the Marksburg, an old medieval castle. Since that incident two days ago suddenly stories have aroused from a mysterious apparition on the Marksburg, called the white lady... The scientists now fear that the charwoman could cause any serious time inconsistencies with terrible results for the presence and future. The player is charged with the rescue of the charwoman without affecting the course of time. For his mission the player is fitted with a specially improved mobile device (e.g. PDA), that allows trans-time communication and documentation of the entire trip in the past. While being transformed to the past through the time tunnel something goes wrong. The last thing he hears from the scientists are their curses and then he loses his consciousness. Suddenly the player finds himself in a crowd of excited people rushing towards the gate of an unknown castle. In the hustle he loses his PDA and tumbles in the nearby ditch. Recovering from his fall he looks up. As in slow motion he sees some person fetching his PDA from the ground and peering at the device. Before he is able to call him the guy melts with the crowd again, disappearing in the castle...

Game scenario

The prologue introduces the framework plot of the game. It will consist of video sequences and be designed in two variants. The default prologue is a pure virtual video sequence at the beginning of the online adventure game (Eduventure part 1). Alternatively the player can start with an augmented prologue at the Marksburg. Therefore one makes a tour through the castle with a mobile computer device (see 'Technological base'). On certain points of the castle the player can see the original site augmented with video sequences or graphics through his device. Due to the character of the prologue no interaction is planned. But after finishing the augmented prologue one can create a player account for the Eduventure game at the Marksburg. If afterwards one starts the online game with his account, the system knows of that augmented tour before and offers a specially adopted introduction in the game. As in the video prologue the information is presented as an entire movie, in the augmented prologue only mysterious but relevant video sequences (e.g. the apparition of the white lady) are shown at certain locations. Although the information included is of importance for the later game play the relevance of the scenes is at that point uncertain to the player. Thereby curiosity is fostered and one should be motivated to play the online game (Eduventure part 1).

The online adventure game includes three main tasks, consisting of different quests: Firstly to retrieve the lost mobile device (PDA) and to find out the historical period in order to re-establish communication with the scientists. Secondly to find and to send the charwoman back to the presence. Thirdly to find and fix obvious time inconsistencies caused by the charwoman. To solve these tasks the player has to apply knowledge of the historical period and the Marksburg on concrete problems. Whilst playing he has also to collect certain artefacts. One artefact allows to magically entering a secret and hidden chamber from any place in the castle. Therein he can deposit artefacts and left notices for the further game play, which so outlast the times. Some information (documents) can be found within the game, other has to be explored externally. How the player acquire necessary knowledge is left to his own considerations. After completing all tasks the player returns to the presence. The online game ends with a short video sequence. The player is told that obviously not all time consistencies have been fixed and something inexpressible might result out of that in the near future. To prevent this menacing future one has to investigate the Marksburg in situ. Thus he will be equipped with a special mobile device which allows 'sights' in the future and to identify possible inconsistencies. Besides it visualizes remains of his game activities in the past (online game). The player is asked if he is willing to accept the new mission. He can decide to let the game end at this stage or to go on with the game.



Figure 4: Augmented view of the Riders' stairway at the Marksburg through a mobile device [concept art].

Eduventure part 2 is a presence scenario at the Marksburg. The player has to identify inconsistencies and other hidden hints in a sort of augmented paper chase. The aim is to discover the secret hidden chamber with artefacts. The game play ends if he chooses the correct artefact in the chamber. Then he receives a description of the way to a certain room at the Marksburg, which he can easily find by his experiences of playing the online game. The game ends with congratulations and he receives an award for solving the game (e.g. a certificate with a photo of him at the Marksburg as a souvenir).

Actual state and outlook

At the end of 2004 the conceptual framework and the technological base of the Eduventure was specified as described. Currently the story elements with the pedagogical tasks are worked out in detail and the technological base is tested and conducted. The proof-of-concept is scheduled for 2005. Both the online game and the augmented game are tested. The prototype will be evaluated against the different objectives of the pilot project. The Eduventure approach and the combination of AR and mobile computers deployed in the prototype are evaluated against the pedagogical objectives aforementioned. Of particular interest are possible transfer processes: Does the Eduventure as a blended game based learning approach facilitate learning transfer between playing in a virtual world and knowledge construction in the real world?

This pilot project is intended as just a starting point for a more detailed and elaborated future development of the Eduventure. The work necessary for the conceptual design and implementation of such an extended project requires recognizable financial effort. The parallel focus on tourists as a target audience of the Eduventure allows a commercial usage of the project and might financially support the further developments. Therefore the augmented prologue could be used as a kind of teaser, for instance for tourists on the Marksburg, who can borrow a mobile device for their augmented tour through the castle. Also players of the online game could become future tourists.

Acknowledgement

This work was financially supported by the Ministry of Science, Further Education, Research and Culture of Rhineland-Palatinate in Germany.

Thanks to Ulrich Wechselberger and Matthias Biedermann for their creative and committed contribution to this paper.

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