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Mobile Co-operative Game-based Learning with Moles: Time Travelers in Medieval

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Abstract: In this paper we examine how 6th grade students independently develop and play a *mobile co-operative game* in their art course. The children are brought into the Middle Ages, where they deal emotionally and actively with historical artifacts in physical space in and around the museum. By integrating children's day-to-day experiences in their digitally-saturated lives, particularly the common use of mobile devices, the conceptual design of the co-operative game fosters a further differentiation of the students' aesthetical perceptions and actions. The students use the mobile learning system *Moles* to become aware of and have fun discovering ancient times. The attention of the project is to focus on the functions of creating and playing *mobile learning games* as an aesthetic learning process. Hence, the students reflect on traditional and digitalized assisted forms of media within historical contexts. The results of a step-by-step evaluation of artistic didactical approaches are presented and discussed.

Introduction

Mobile learning games integrate mobile devices such as mobile phones, PDAs or tablet PCs to connect the real world with the digital world. Real world games that are augmented with computing functionality and supported by the combination of real and virtual game elements create new and exciting gaming experiences for highly motivated learning. Here, in contrast to already existing *mobile learning games*, the students create the gaming scenario themselves. *Moles (mobile learning exploration system)* is a software system for teachers to support students in their individual learning processes. While preparing the game's structures themselves, the students constantly create questions arising from a confrontation with the medieval aesthetic artifacts. When creating fictitious characters of their age group, they visualize these characters as avatars in a meaningful context which leads to a sustainable emotional interaction with medieval times. Whilst playing, the students act within their roles, but at the same time they - with all their senses, physically stay in the present world.

The teaching project *Time Traveler's in the Medieval Ages* is conducted as an iterative evaluation process. This method of *iterative design and development* is used in the on-going development of the application *Moles* (Melzer at al. 2007). The first survey concentrates on user habits concerning mobile devices and actual (basic) knowledge about the Middle Ages. The second survey is based on the inner structure of the game's concept. Whereas, the third mirrors the learning potential in regard to pedagogical, aesthetic and technical aspects of the learning project.

Throughout this project, the children reflect aesthetically and scientifically upon historical facts. The major learning effect occurs when the children create and play the co-operative learning game, which constitutes a connection between their ideas of conditions in the Middle Ages and the culture they are currently living in. We believe that the learning scenarios created with *Moles* by children are strong evidence for why we should integrate the design of *mobile co-operative learning games* in education processes.

Brief History

Within the KiMM Initiative of the Institute for Multimedia and Interactive Systems (IMIS) at the University of Luebeck in Germany, a team of university researchers, secondary school teachers and students constantly develop new scenarios and applications for technical assisted mobile learning projects. For more than seven years we have developed different kinds of innovative learning technologies and learning scenarios and transferred them into primary and secondary school education systems. The aim of the KiMM Initiative is to establish pedagogical models and technological tools to use for the acquirement of digital media literacy. The research- and transfer-oriented initiative promotes holistic, project-oriented, interdisciplinary and trans-disciplinary learning as well as creative and artistic use of digital media. New interfaces for human-computer interaction (HCI) specialized for a K-12 target group are developed by scientists, teachers and school children together.

The core aspect in the development of mobile learning applications at IMIS is the application *Moles*, which encourages an independent and co-operative development of outdoor learning scenarios. Further goals for the students' learning processes deal with "life's difficult questions" (by observing, measuring, and interviewing people), to present and reflect about their experiences and the results of what they learned, and hence construct sustainable knowledge. *Moles* also functions as a tool to develop, play and assess mobile learning games (Melzer et al. 2006). The IMIS has developed computer-based learning technologies which have already been integrated in day-to-day teaching scenarios in schools. Initiating learning by using creative, wearable, tangible, ambient, mobile and participatory (Web 2.0) media to augment or intertwine the physical with the digital realm, has proven successful for educational issues (Melzer et al. 2006a; Melzer et al. 2006b; Winkler, Goldmann & Herczeg 2006; Melzer, Hadley, Winkler & Herczeg 2005; Melzer, Hadley & Herczeg 2005).

The development, testing, and evaluation of the mobile educational game *Time Traveler's in the Medieval Ages* constitutes a further assessment of mobile learning games, which have already been examined at IMIS so far. In contrast to rather traditional pervasive games based on the principle of competition, *Time Traveler's in the Medieval Ages* encourages collaborative learning and exploration. It illustrates the potential of the application *Moles* to initiate new, collaborative game structures and creates a productive atmosphere, which supports the learning process.

As in all school projects of the KiMM initiative, the students are the main participants in all aspects of project. They produce the storylines, rules of game, and content in the *Time Traveler's in the Medieval Ages* project. It is their responsibility to define, design and realize all the tasks and artifacts in the project by themselves. The teachers act as facilitators to assure a productive communication within the different work teams, to manage occasional problems by mediating between the members of the groups, and to help the students to adopt a structured working method.

Related Work

Mobile Learning Games

The main difference between the learning project *Time Traveler's in the Medieval Ages* to already existing mobile learning games is, that students create the game themselves. In addition, no large size mobile devices such as the tablet PC as in *CatchBob* are used (Nova 2007). *CatchBob* is a collaborative hunt, in which groups of three persons have to find and circumnavigate a virtual object on campus. The game intertwines elements of multi-user, location, and social interaction. The *mobile Game* (Schwabe & Göth 2005) shares this structural concept of teams competing against each other while solving different tasks. Another major difference to existing mobile learning games is the aspect of interactive playing. This is evident in the mobile learning game *Savannah* (Duncan et al. 2004), in which students simulate the hunting habits of lions in wilderness by using digital mobile technologies. In these other projects is not the students themselves who create the gaming content and structure.

Mobile Systems in the Museum

Today, there are more and more museums providing mobile information systems. A common feature of all these systems is that they present pre-processed contents. At the same time when digital multimedia systems allow new forms of presentations in museums they are fostering the problem of loosing the main focus - the real artifacts themselves. Instead of interacting with the physical environment, the visitors are concentrating on the digital devices themselves, thus ignoring the environment while looking down at the devices. Therefore, mobile

applications need to be designed explicitly to free the learners' focus, to awaken their senses and to put the technology into the background.

Learners should mainly interact with their immediate environment within the museum while still making use of the advantages of computational powers (Göth, Frohberg & Schwabe 2006). With the application of *Moles* the mobile learning game is designed in that way that - in contrast to commonly used systems - the learners themselves create the learning game for the museum outing. The learners are constantly activated mentally and physically, they interact with their immediate environment and its eminent objects. Throughout the game, the learners' attention can be captured by introducing thrilling stories with characters they can identify with, rather than merely consuming historical information out of context of their day-to-day life. Thus, while playing, the learner's awareness is focused on the physical artifacts. In this sense, learning is marked as explorative, immediate, co-operative and contextual. And in the end, the core reason to visit the museum, namely seeing the physical artifacts, is supported.

The Art-Project Time Traveler's in the Medieval Ages

The major aim of this art project in school is to enable students to gain insight in the lives of children of their age in medieval times. By creating, playing and assessing a co-operative role play which provided eminent information about the Middle Ages, such as the predominant social system, typical professions and daily routines, this game provides an experience-oriented approach to selected pieces of art of the Middle Ages. By introducing characters of the same age group (Fig. 1), who speak their colloquial language (Fig. 2), the co-operative role play helps students to identify with these characters. Within the teaching units the students independently examine and discover the multiple facets of this project while being guided by the teacher. Concentrating on their research results, the children create the setting of the role play and work on the inherent concept of the game. The contextual frame is provided by a local museum (St. Anne Cloister, Luebeck) and the surrounding old city center which provides multiple medieval settings and extraordinary scenery for the role play. Each single group of 3 students receives a city map of the Old City and a floor plan of the museum on PDA (Fig. 3). Visual representations of the locations are listed on these PDAs. The task setting is limited to a specific location only and access is given by the system exclusively. The children have to navigate between the different stations independently in order to play along the storyline. There are specific tasks requiring co-operative efforts of all groups at certain meeting points in order that the students not only work within their team but have to cooperate with all the learning-groups.

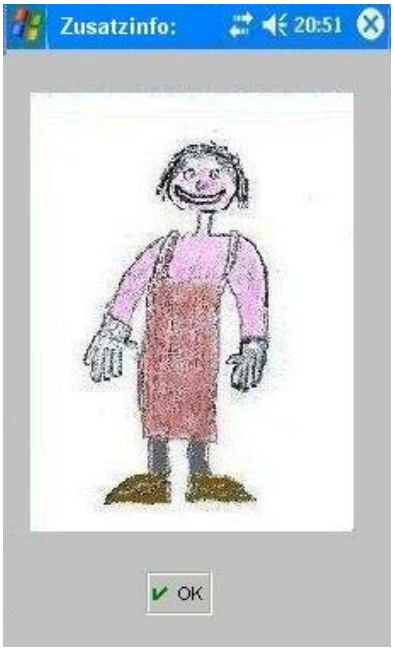

Fig. 1: Avatar on mobile devise

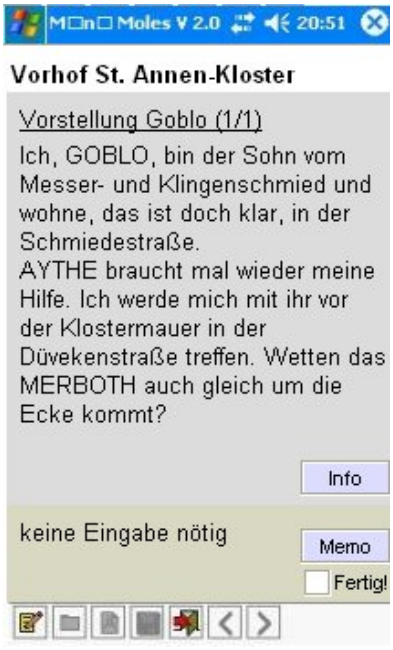

Fig. 2: Colloquial language of students on mobile device

Fig. 3: Floor map of the museum on mobile device

Fig. 4: Research on medical plants of the medieval ages

Fig. 5: Playing the game in the streets of Luebeck

Fig. 6: Playing the game in the *St. Anne Cloister*

The pilot schema is structured by the following stages:

- research on medieval topics (Fig. 4)
- developing a concept for a student-oriented design of games
- developing specific characters (identities) by the students themselves
- developing a concept for a collaborative game specifically for museums
- introducing students to PDA and the application *Moles (Mini Moles Loc)*
- self-dependent accomplishment by students of the role play
    - PDA-assisted navigation between the different locations of the story line
    - solving local tasks within and between the teams (Fig. 5)
    - exchanging experiences after the role play

The individual, self-directed research, the differentiation of the single characters and the self-contained creation of a design for the game itself constitutes a multi-faceted and holistic approach between learning matter and learners. In a scenario-based role play, the students learn how to internalize basic knowledge about the Middle Ages (Fig. 6). The approach is scenario-based, because a playful approach for constructing knowledge causes an effective and long lasting learning process. This intuitive impulse is vital for an effective and lasting impact on students' learning capability. The sustaining construction of cognition, and the insights in the reciprocal action of physical being in time, is accelerated by multi-modal experiences as well as a close connection to contents of teaching to a representative real-physical living space. Furthermore, the children's methodical, social, and functional competences are fostered in class by activating productive-creative processes such as introducing co-operative learning structures as well as providing an ambience in which constant exchanges of experiences within the different teams are encouraged.

Didactic Aspects

Playing is Learning

"*The words to describe the elements of the game mainly derive from the fields of aesthetics. They are words trying to describe the impressions of beauty: tension, balance, tare, replacement, contrast, variation, connection and redemption, solution, the game bonds and releases. It banishes, which means: it fascinates.*" (Huizinga 1998)

Whilst playing, everything is possible. In analogy to their stage of development children take different roles and experience different options. The game "*… is based on freedom and acting according to the rules, it has no purpose and facilitates learning processes.*" (Schröck 2006). According to Johan Huizinga playing is acting freely. Hence there is a close connection between the idea of the game and the idea of art. Also, art and computer games have much in common. They both share the principle of participation and collaboration which becomes more and more important. The latest computer games share the tendency to integrate the real world into the fictional world of the player, which becomes evident in e.g. Nintendo's *Wii* or most obvious in portable pervasive games which are even played on the street with mobile devices.

As Friedrich Schiller (1967) refers in his letters "*About the aesthetical education of man*" to the meaning of playing in contrast to the specialization and mechanization of life to emphasize the holistic competences of man. Also Herbert Marcuse (2002) supports a return to the aesthetics and the idea of playing to set free a discussion according to freely chosen rules and the sake of their self. A game's rigid learning structures

can be dissolved and settings alternated in that way that new and unknown learning potential is emerging.

The integration of contemporary media within the "mobile co-operative-learning-game" in museums, can lead to a multi-sensual understanding of the world. The interactive role play focuses on participation and collaboration as well as on an enhancement of the real world by the interactive digital system. Due to the independently created stories and identities as well as the communication of co-players a mental immersion into the medieval world takes place. All the intensively experienced incidents lead towards a lasting, changing, and broadened perception of the world. By incorporating a physical environment like a museum with its physical artifacts a transition from a mental to a more physical immersion is possible.

Learning within the institution museum

Learning in museums predominantly follows the traditional concept of information transfer. This concept uses information-media (books, worksheets, textual devices), but also increasingly, on AV media (audio players, computer displays on POIs or PDAs). The learning occurs rather incidentally as a side-product of experiences than as an intentional information learning process (Schuster 2006). One-dimensional, rigid learning patterns and learning conditions prevent the students from identifying, articulating, reflecting and exploring. Action-based experiences, explorative learning with immediate references to the real world, the differentiation of knowledge by multiple perspectives and contexts related to interactive, multi-modal learning-arrangements provide a wide range of activities. Thus, the co-operative learning game *Time Traveler's in the Medieval Ages* and its introduction of the *Moles* application offers students numerous activities and broadens the learners' horizons by involving the students physically, as well as mentally. It also presents authentic and complex game situations, which ask for self-directed learning and triggers individual associative cognitive deduction chains. By providing narrative anchors and individual paths within the game's setting, and by the choice of actions of the avatars, this game highly contributes to positive learning effects. Authentic actions and interactions among the students and between the students and the system, too, lead to a sustained learning process concerning historical contexts.

Successful learning which is supported and structured by digital technologies within the context of the museum takes place in the interdependence of impulses and challenges as well as motivations and experiences of success. Discovery-based learning can be considered as the major principle of self-directed student actions where emotionality and experience have an important impact on the learning potential. Other than the commonly observed results, the interactive media shall not detract the learners' attention away from the initial objects. They could rather trigger off an intense interaction with the object itself. If you have a small display, like on a PDA or a mobile phone "*… your are still largely present in physical space; the display adds to your overall phenomenological experience but it does not take over. So it all depends on how we understand the idea of addition: we may add additional information to our experience – or we may add an altogether different experience.*" (Manovich 2003).

Evaluation

Within the course of the teaching project, three evaluations took place in the 6th grade with 29 students (21 female, 8 male) at a secondary school. During the first evaluation, the students were asked about their knowledge of the Middle Ages and their user habits concerning small, mobile communication tools (PDA, mobile phone) before the learning-project started. Only open and standardized questions were asked. The following figures represent the number of answers concerning specific content. Thus, the figure 12 illustrates that 12 students chose this category singularly or besides others. Topics which were chosen less than four times were excluded due to their marginal impact on the assessment of the overall results. The question about the students' knowledge of the Middles Ages constitutes the following major categories in decreasing order:

Military units/knights (12), kings (11), castles/palaces (7), followed by cruelty (6), wars (6), and illnesses/insufficient medical care (5) as well as the lack of modern media (4). The students attained this knowledge by acquiring the following information resources: books (13), internet (11), school (9), films (6), museums (4), and TV (4). In contrast to their previous knowledge the students were keen on finding out more about the living conditions of the Middle Ages, particularly those of children (17) and focusing on aspects of warlike operations (5). Concerning the question where they have seen objects from the Middle Ages so far the students repeatedly gave the following examples: the local *Holstentor-Museum* with its torture chamber, old tools, armors and paintings (6), or the *Ahrensburg Castle* close to the city of Hamburg with its chambers, the near surroundings, the chapel and knight's armors (5). The reasons to visit a museum can be categorized as initiated both by the school (20) and intrinsically motivated (19). Visiting a museum means for the students: boredom (16), sometimes great topics (9), curiosity (9), and interest (6). Concerning the living space Luebeck

rather the *Holstentor-Museum* (13) and the *Natural Sciences Museum* (9) are of significant interest than the *St. Anne Museum* (6), which constitutes the basis of the learning project. Furthermore, the students' use of mobile phones and PDA constitute the first phase of the evaluation. All 28 students actually used PDA in the course of the school project whereas only three students gained experience with this tool in a private context, too. Mobile phones are used explicitly in the private domains, e.g. to phone people (23), to send/receive SMS (19), to take pictures (5), to listen to music (5), and to play (5).

A second evaluation shows the students' learning behavior during a traditional pedagogical service of the museum with five observers (3 students, 2 scientists). The documentaries are based on video monitoring and supervision sheets. The evaluation shows that students are initially highly motivated and actively participate in the teaching attempt by answering the questions of the museum educator. Due to the fact that the museum educator hardly anticipates any immediate incidents of the Middle Ages, a meaningful context which touches both the students' lives and the artifacts is not established. Time after time, the students' attention wanders: the girls interact mostly with each other: scribble, draw, babble, look at other objects within the room or braid their hair. The boys play with pencils or their worksheets. Generally, the students become more and more distracted and agitated.

In the course of the mediation the level of abstraction of the contents increases, particularly concerning complex phenomenon as e.g. with the *Passion Story* at the *Memling Altar*. In the meanwhile, the lack of self-directed learning experiences leads towards an increasing disinterest of the students in the learning matter.

The third and concluding evaluation examines the learning impact of the introduced tools PDA and the software *Moles* regarding students, parents and teacher. This happens on the background of the mobile game-based co-operative learning concept, in regard to motivational, interactive potentials. In detail, the third evaluation exemplifies the concepts' underlying aim to establish a more intense and productive interconnection between the medieval objects and the learners' daily lives by making use of the game-based co-operative learning concept. There are four major question groups: *handling the software*, *teamwork*, *learning game*, and *self-assessment of the learning progress*.

Concerning the answers to the questions a scale from 1 = "does not apply at all" to 6 = "applies fully and completely" has been used. For children and parents the mean (arithmetic average) (*M*), the standard deviation (measure of statistical dispersion) (*SD*) and the median (relative frequency, not influenced by extremes) (*MD*) were calculated.

Students:

Handling the software: Without any derivation between male and female students it is explicitly affirmed that all students are capable of managing the software. (M 5,4; SD 0,9; MD 6). Also, all students proved their capability to interpret the control points at the digital map successfully (M 5,1; SD 0,9; MD 5) and localize the different sites in town and museum with the help of the digital map (M 5,1; SD 1,1; MD 5,5). A small group of female students bothered about the fact that the site map and floor plan of the museum were both represented on the same worksheet. (M 4,7; SD 1,6; MD 5). About a third of the students closed the application unintentionally whilst playing (M 4,1; SD 2,1; MD 5). Accessing the game by entering a password was generally well accomplished. (M 5,3; SD 0,9; MD 6).

Teamwork: The teamwork within the different groups, each playing one character of the Middle Ages, was according to the students' generally perceived as good except for one case (M 5,5; SD 0,9; MD 6). Due to the lack of mobile devices at the school three students had to share a PDA. Approximately one third (predominantly the male students) specified that they only could work insufficiently with the PDA. (M 4,1; SD 1,8; MD 4). The half of the students (male and female students likewise) hold that the teamwork between the groups succeeded, the other half negate that. A possible reason based on the superficial handling with text-based information on the mobile device. In contrast to their male group members the female students did not see the intended necessity to form learning groups in stages of occurring problems of comprehension (M f (female) 3,9; M m (male) 5,6); (SD f 1,6; SD m 0,8). Total figures: (M 4,5; SD 1,6; MD 5). Merely four female students used rather less additional information-material in order to help an other group (M 4,7; SD 1,1; MD 5).

Learning game: All female students liked to act out a role (M 4,9; SD 1,1; MD 5). Rather the male students (approx. half of them) would have liked to obtain an own role within the game (M m 3,1; M f 2,8); (SD m 1,9; SD f 2,1). Total figures: (M 2,9; SD 1,9; MD 3). The students vehemently articulate their wish to introduce PDA-assisted learning games within education (5,0; SD 1,3; MD 5).

Self-assessment of the learning progress: Male respectively female students are generally of the opinion that they learned something whilst playing the game. (M 4,0; SD 1,6; MD 4). The majority of the students also think that they learned more and better by creating and playing *Time Traveler's in the Medieval Ages* in comparison to

the didactical approaches of the museum educator (M 4,0; SD 1,7; MD 4). Notably the male students state that by creating and playing the game they memorize their knowledge about the Middle Ages sustainable (M m 4,7; M f 3,7); (SD m 1,3; SD f 1,9). Total figures: (M 4,1; SD 1, 7; MD 4,5).

Parents:

Parents observe that their children rather play than learn with the digital media (M 3,69; SD 1,07; MD 4), which is true mainly for the boys but not necessarily for the girls (M m 5,5, SD 0,50; M f 3,36 SD 0,77). Parents put emphasis on the aspect that children get introduced to the contemporary, digital media (M 5,7; SD 1,34; MD 6). They also think that their children profited from the PDA-assisted Middle Ages project in a meaningful context (M 4,21; SD 1,52; MD 4). Whereas, a third of the children did not report the working processes of the Middle Ages project itself at home, they all gave account of the realization of the game. After the Middle Ages project the parents were predominantly of the opinion that their child was introduced to major aspects of the Middle Ages by a meaningful, authentic and student-oriented approach towards medieval works of art (M 4,00; SD 1,15; MD 4). Only one fifth of the parents cannot testify any learning progress of their children concerning the memorization of learning matters attributing to a media-assisted approach within the course of the project whereas four out of five admit to the game's impact on the students' memorizing processes (M 3,67; SD 1,62; MD 4). Merely one third of the parents believe that the self-directed learning within the Middle Ages project (biographies, drawing the characters, developing the inherent plot e.g.) does not account for any joyful experiences (M 4,13; SD 1,54; M 5). Whereas the majority admits to the game's potential of providing contexts fostering fun experiences (M 4,80; SD 1,42; M 5,5). Two thirds of the parents stated that they do not know about the manifestation of the learning-by-playing arrangements within the curriculum. The parents' overall opinion is that the learning-by-playing concept should have a deeper impact on day-to-day learning arrangements (M 5,07; SD 1,29; MD 6).

Teachers:

Handling the software: The students are generally capable of managing the application *Moles* (6). *Moles* is an adequate tool within the development and playing-process of a co-operative Middle Ages-learning-game (6). The application of *Moles* is easy to use for the students (6). The avatars created by the students provide a potential for identification with the specific characters of the roleplay (6). The students manage successfully to navigate between the different sites in the near surroundings of the museum by using their maps (6). The teacher does not think that the students really read the information (texts) carefully (2). She is of the opinion that the application *Moles* itself offers enough possibilities to the students to create and play a creative and effective learning game (5).

Teamwork: The working processes within the single teams in the phase of the development of the game was good (5). The students made enough use of the PDA within their groups of three (5). Also, the students who had to develop a character cooperated well (6). The students of the single groups made use of additional information whilst developing their characters to help other groups (5).

Learning game: Unfortunately, with this game there was initially not enough time given and not enough roles offered (2). The students rather wanted to act out an own role with an own mobile tool (4). Thus, the teacher concludes that students should have more opportunities to gain experiences in learning with games within everyday learning arrangements (6). Consequently, it is important that students are motivated to integrate contemporary medial accomplishments within their learning-processes (6). The role play provided meaningful and authentic examination of the teaching matter (6).

Assessment on the learning progress: The students, according to the curriculum, learned sustainable and in relation to their daily life whilst playing the game (6). Also, they learned more by actively developing and playing the game than by merely learning passively with the museum educator within the museum (6). Even more, the students can memorize certain learning matters better due their active involvement in the learning process (6). *Moles* fosters team-learning (6) and initiates a multimodal learning, full of experience on site in the midst of the student's daily life (6). The underlying structure of *Moles* motivates students to interact with artifacts (here of the Middle Ages: paintings, sculptures, architecture) (6).

Summary and Conclusions

The results of the evaluation demonstrate that the students' relationship to reality is broadened with collaborative independent game design using the application *Moles*. *Moles* provides authentic and meaningful interaction while it differentiates and broadens the students' perspective concerning historical artifacts. The

underlying conceptual structure of *Moles* fosters artful and aesthetical perception and interaction, notably those of discovering, experimenting and interpreting acquirement of the physical world. In contrast to common procedures of mediating information within the institution museum, our projects intertwine learning content and the physical surroundings offer multi-modal and event-based experiences. The development, design and actual playing of the co-operative learning game provide a student-oriented, complex approach to medieval pieces of art. A meaningful and authentic context is given as the students constructively have to alternate their perspective on today's social and cultural issues to the given scenario of the Middle Ages; in order to adapt their roles within the game and to gain an experience of success at the end of the game.

In view of the multiplicity of teaching units taught with *Moles* and the results of over twenty evaluations within the framework of the KiMM-Initiative, it is evident that an efficient way to learn is by creating, designing, and playing in the midst of the physical world. Also, we conclude that it is not the technology alone that will make a difference, but how teachers use and integrate digital technology within learning processes. *Moles* is transferable to everyday classroom teaching and learning scenarios as it is easy to use, is freeware, and requires comparatively inexpensive hardware. Within the teaching projects, *Moles* was tested on inexpensive PDAs. Hence, from 2008 onwards, *Moles* is going to be accessible by mobile phone providing a common basis for all kinds of pedagogical work as many students own a mobile phone with the necessary software system requirements. Also, a web-compatible version of a server-based application of *Moles* is under development to provide online access via browsers to initiate co-operative learning game scenarios in many kinds of pedagogical contexts.

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