
Comic Experience: Narrative & Collaborative Drawing on a Multi-Touch Table in an Art Museum

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Abstract—Most art museums provide audio guides or, more recently, multi-media guides, with static context such as background information to enrich their exhibits with an extra layer of content. Usually, there is no actual interaction with the museum’s exhibit possible, no hands-on experience that fosters a deeper cognitive engagement. The integration of multi-touch tables has a great potential for collaborative experiences. We designed a touch table application that allows for collaborative and active drawing experiences and conducted two usability studies, one in a laboratory setting and one in the field. The design study was structured in three phases: domain and problem analysis, user experience and interface design, and evaluation. The results show that the collaborative aspect – drawing on one picture simultaneously in different personal areas - was accepted and praised by the visitors. The study indicates that museums with mostly passive viewable artefacts can profit from interactive and collaborative content, which enhances the general experience in their exhibitions.

I. INTRODUCTION

In art museums the exhibition design is limited, because their focus is on displaying collections of objects such as paintings, sculptures, multimedia works, and installations. Usually, there are hardly any opportunities for visitors to interact with artefacts or other visitors, other than discussing exhibited objects. Most art museums try to increase their visitors’ interactivity by handing out handheld devices providing static content like audio tours [1], [2]. Multi-touch technology, in combination with appropriate interaction design concepts, allows for true interactivity between visitors and the exhibition objects. The presented research examines the emerging role of interactivity with exhibition objects by developing a collaborative drawing and viewing application running on a multi-touch table and a web application for smartphones. The collaborative drawing and viewing application adds interactive elements in accordance to the visitors’ desire for self-expression. The interactive comic experience specifically developed for the Karikaturmuseum Krems makes drawing for visitors easier, actively engaging them with drawing styles of exhibited artists, and allows collaboration with other visitors, even outside of the context of the museum.

Based on a user-centered design approach we conducted a design study to investigate whether using the collaborative drawing application introduces novel user behaviors or social interactions. Moreover, we studied how digital brushes have to be designed and implemented for strokes performed by human fingers in order to work well on the touch surface, independently of the target group and its drawing skills. To

answer these questions, we applied an ensemble of research methods: First, we identified user’s needs and created personas and scenarios. The needs were then taken into account while developing paper prototypes and the interactive application. Furthermore, two usability studies (one in a lab environment, one in the field) were conducted to evaluate the multi-touch application in general, and the user interface in particular.

In the next section we discuss *Related Work* dealing with multi-touch and multi-user approaches in museums, participatory projects and drawing applications. The section *Design Study* describes the research methods used during the development of the application and the application’s features. In the section *Evaluation* we give details of the procedure, participants and test results of the conducted studies. In the section *Discussion* we summarize and interpret our findings of the two usability studies. Finally, we discuss possible directions for future research in the section *Conclusion*.

II. RELATED WORK

Large-scale table-top devices have already demonstrated their great potential in public use of interactivity and collaboration in the past. In 2002, the project *SmartSkin* [3] investigated a new sensor architecture for making interactive surfaces sensitive to human hand and finger gestures. Besides technical achievements, the study of Rekimoto [3] also reported new insights into interaction techniques using multiple fingers. One year later, a study with *Diamond Touch* was conducted by Dietz and Leigh [4]. They proposed a touch-sensitive input device which allows multiple, simultaneous users to interact in an intuitive fashion. Nowadays, multi-touch table-top devices can be found in various locations such as airports, information centers, retail stores, and museums [5], [6]. To provide an overview of work related to our problem domain, we focused on multi-touch and multi-user table-top applications, participatory projects, as well as drawing applications.

A. Multi-user Table-Top Applications

The Museum of Science and Technology in Islam [7] demonstrates 1500 years of history of Muslims on a large multi-touch table. Visitors can simultaneously interact with the application and create a social learning experience. Furthermore, Horn et al. [8] conducted a survey at the *Harvard Museum of Natural History*, showing that visitors collaborate effectively and engage in on-topic discussions of the exhibition. They presented a design and evaluation of a table-

top multi-user game to help visitors learn more about evolution. The multi-touch table installation of Hornecker [9] in the *Berlin Museum of Natural History* demonstrates that information-browsing applications may be inappropriate for a museum's context, as it was not used much and hardly provided discussion topics. The potential of interactive tabletops was not exploited satisfactorily.

Multi-user scenarios can also be found in other areas besides a museum's context. Blumenstein et al. [10] have described *inter alia* general requirements and challenges for multi-user and multi-device scenarios from the perspective of interactive data visualization.

B. Participatory Projects

Ideum [11] developed a photo kiosk for the *Crystal Bridges Museum of American Art* in conjunction with the exhibition *Warhol's Nature and Jamie Wyeth*. The participatory aspect of the project was that visitors were able to capture their own photograph and then choose different style elements to apply to their photograph based on the works of the two American artists. After styling their photograph, users could send it via email to either themselves or others.

Moreover, the *Indianapolis Museum of Art (IMA)* developed a number of participatory projects [12]–[14] that allow visitors to contribute to the museum experience by creating their own content and sharing it with the public. In 2013 the IMA launched a drawing competition with the *Matisse, Life in Color* exhibition encouraging visitors to create drawings inspired by the works of the French artist [12]. This concept based on an app available on a number of iPads was installed in the exhibition entrance. The created drawings could then be submitted via the app to a provided competition website, where people could view submissions and rate and comment the drawings. IMA stated that this participatory project worked well, because visitors could see themselves and/or their works represented within the network.

C. Drawing Applications

There are a number of drawing applications on the World Wide Web where users can draw on their own device and then share it with others or draw collaboratively over the web. *Awwapp* [15] and *sketchpad* [16] are two well known examples. *Awwapp* offers collaborative drawing by connecting through the Internet. The available functions are very basic but effective. Basic functions that most of the applications include are a pencil with different sizes and color, an eraser, texts, and sometimes images that can be placed. Deleting the whole image, as well as saving and sharing it, are additional functions. Drawing applications on multi-touch tables can be found in domains like design, in the form of a brainstorming tool [17] or in educational organizations [18], [19]. Partarakis et al. [20] presented a painting game for pupils, introducing physical objects to a large touchscreen. The aim of this installation was to teach drawing techniques to pre-schoolers.

Beside the work of Partarakis et al. [20], the usage of drawing applications on multi-touch tables in a museum's

context has not been investigated. Apart from these studies, there is a lack of research on the integration of drawing applications on multi-touch tables in a museum's context, especially for art museums with the focus on collaboration and participation.

III. DESIGN STUDY

Our design study is divided into three parts: gathering information to deduce requirements, conceptual design for an easy-to-use interactive comic experience, and evaluating the application to identify problems.

A. Requirements Research

The first step in the process of defining requirements was to collect qualitative data about the potential users of the museum. In this research phase real world observations and interviews were conducted. After collection, the information was modeled in form of personas. In the final stage scenarios were developed to define the requirements.

1) *Observations & Interviews*: Firstly, we physically visited the museum to gain insights by interviewing the museum's employees and conducting observations such as: what does the exhibition area look like, what is the average exhibition period or who are the visitors. Four employees of different functions were interviewed: the director of the museum, a cashier, and two museum warders. The conversations took roughly 15 minutes. The museum provided all their data they had already collected about their visitors over the years. During the observations we also analyzed published advertising materials, the gift shop and the guestbook. The document analysis showed that the guestbook is full of sketches and little cartoons, showing the visitors' desire to express themselves not only graphically, but also by relating their drawings to the context of the museum's exhibition.

2) *Personas & Scenarios*: Based on the interviews and observations three personas [21] were created: an older married couple, a class of high school juniors and a young guy in his twenties. These personas became the main characters of the developed scenarios. The scenarios describe their visits to the museum, why they go there in the first place, how they act in the museum and how they react to and interact with the table. Storyboards have been created to illustrate the scenarios (Figure 1). The output of this process was the requirement definition.

3) *Results for Requirements*: The target group of the museum includes nearly every age group (young children as well as retirees), and different social groups (tourists, students, regulars). Regarding the touch table the target group is reduced to people interested in technology. The list below presents user requirements for the target domain:

- **Expressing themselves graphically**: The paper guestbook shows that visitors express themselves by drawing funny sketches based on the exhibition topic.
- **Collaborative work**: Sketches in the paper guestbook are often drawn by more than one person.

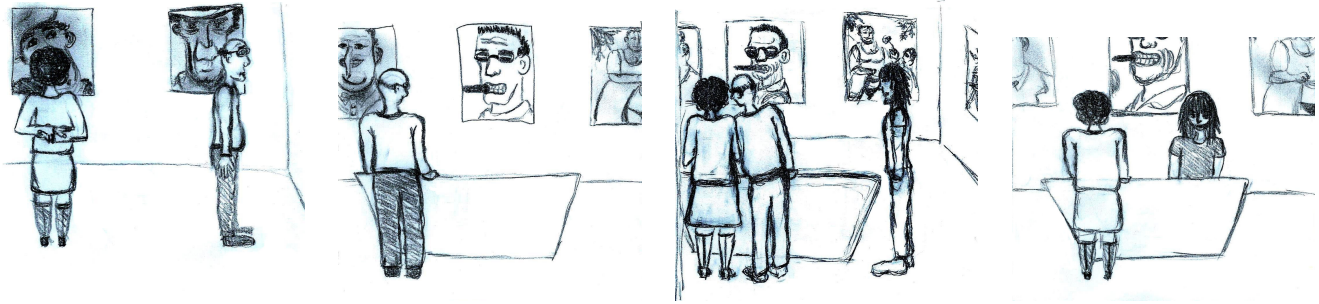


Fig. 1: Storyboard image from one of the scenarios in the museum exhibition: An elderly married couple visits the Karikaturmuseum Krems and comes across a touch table. The husband is interested in new techniques and shows his wife how to read comics on the table. Tom joins them at the table and starts the drawing application. The wife is all eyes and copies his interactions. They draw a panel together.

- **Self-representation:** The drawings in the paper guest-book, which any visitor of the museum can flip through, are nearly always signed.

B. Design

Paper prototypes showing the concept of the drawing application and the first design of the look-and-feel of the application were developed. In the next section we describe the final interactive prototype running on a multi-touch table.

The core concept of the drawing experience is the narrative aspect to it. In case of the Karikaturmuseum museum, the visitors get the chance to become storytellers by drawing panels for a collaboratively created comic. The collaboration is not limited to the museum context because user-generated drawings are exhibited both on the interactive table and the web application, once the comic is finished. Visitors who do not wish to draw in public and have their work presented publicly can interact with the table by flipping through completed stories. This way, the multi-touch table caters not only to the needs of visitors who wish to be actively involved in the exhibition, but also to those who prefer to passively take in the art presented.

Start Screen: As proposed and evaluated by Klinkhammer et al. [22], we divided the whole screen into four personal working areas seen in Figure 2, where the user can interact with the tool. The main screen contains elements for drawing comics (pencils) and one element showing already finished artwork (book).

These two features are included to cover the needs of different forms of participation in museums identified by Simon [23]. On the one hand, the visitors, who are “creators”, can produce content by drawing panels for a comic and, on the other hand, the so called “spectators” read and discover finished comics.

To start the application, the user has to drag one element into their personal working area. The selected element then pops up in the chosen area and the user can then either start drawing a panel for one of the provided stories, or look at completed comics (Figure 2). Figure 3 shows the provided

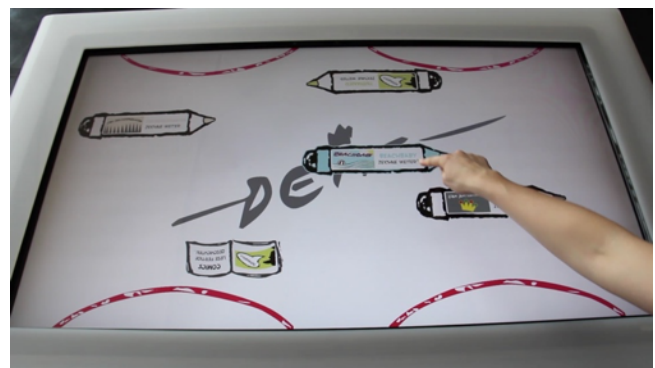


Fig. 2: Interactive element “start screen”: drag and drop a pencil in one of the four semicircles to start drawing.



Fig. 3: Story options to choose when drawing a comic: starting illustrations are caricatures by Austrian artist Manfred Deix.

stories, which are based on famous drawings by Deix, a well-known Austrian cartoonist. Furthermore, the user chooses a story they want to contribute to.

Collaboration Concept: After choosing a story the users have to decide if they want to draw on their own or collaboratively in a group (Figure 4). To work collaboratively, the system provides the possibility to draw individually on two



Fig. 4: Divided Screen – Personal Working Areas: The users are able to work on four areas on their own or collaboratively. This means that users work on their personal working area, but when cooperating with another visitor they draw in their respective drawing areas simultaneously.

different working areas. Each user sees what the other draws in their own working area. To do so, the user needs to share their story before starting to draw. The chosen story then reappears on the main screen, giving other visitors the chance to join this work. If users choose to work on a comic, they get to see the last three pictures that have been drawn for the selected story in the form of a carousel. This way, users get a glimpse of how the story developed so far, without telling everything that has been going on up to this point. By not knowing the whole story the comics should turn out more compelling. This concept was used to encourage the creativity of every user and to get interesting stories.

Sketching: The sketching part of the system provides a drawing application with various tools: brushes, balloons, text areas, an eraser and the functionality of undo (Figure 5).

The basis for the design of the brush implemented on the multi-touch table was the analogue drawing behaviour with a pen. To make it easy to use for the broad visitor audience we integrated one type of brush. The line style of the brush is comparable to a felt pen. To vary the type of brush, a thickness slider with a preview area and a colour palette was implemented. The colours depend on the story the user has chosen.

The interaction concept for adding text elements and bubbles is based on known concepts of graphic applications such as Adobe InDesign or Photoshop. The text box appears on the surface and users are able to drag and drop the box into the place of the picture where they want it to be.

Related to the text input methods, we decided to integrate a soft keyboard based on the QWERTY approach [24]. The physical keyboard elements are mapped to the on-screen keyboard. The touch elements have a squared shape and the size of the touch elements was adapted to a finger-friendly size.



Fig. 5: Drawing Interface

Following the Story: After finishing a drawing, users can sign the comic panel by filling out a form with a name, residence and an email address. Then users can see their picture lined up with the previous panels. This allows the visitors to see how the drawing just finished integrates into the whole comic strip.

By scanning the provided QR-Code on the multi-touch table, visitors can take the story home with their personal smartphone seen on Figure 6. The QR-Code leads to a mobile web application, which links to the comic the users took part in the museum. So, visitors stay in contact with the exhibition and the collaborative aspect does not end when leaving the museum. The integrated QR-Code does not provide extra information about the exhibited arts in the museum [25], but rather complements the mobile website.



Fig. 6: Interface Design for scanning the QR-Code

Reading Finished Comics: The application on the touch table also provides the possibility to look through finished comic strips from other visitors. Thus, the visitors can get an idea of the stories and inspiration for their own sketching work. The interface is arranged similar to the drawing area seen in Figure 7. On the left, there is a tool bar showing the different stories. In the main area, different versions of one selected story are listed.



Fig. 7: Reading finished comics in the exhibition. On the left, the sidebar shows the main stories. The grey area on the right contains all versions of a finished story in the museum.

C. Prototype

The prototype was developed for a 40 inch framed high definition (1920 x 1080 px) table-top, including infrared tracking to discern the touch points. Up to four museum visitors may use the application simultaneously. The application was developed for a multi-touch and multi-user approach and combines a touch table with mobile devices (Figure 8). The system is an interactive installation where visitors can do creative, graphical and collaborative comic storytelling. On the one hand, the users may sketch a drawing and become part of a bigger story and, on the other hand, they can look through already completed artworks by other users.

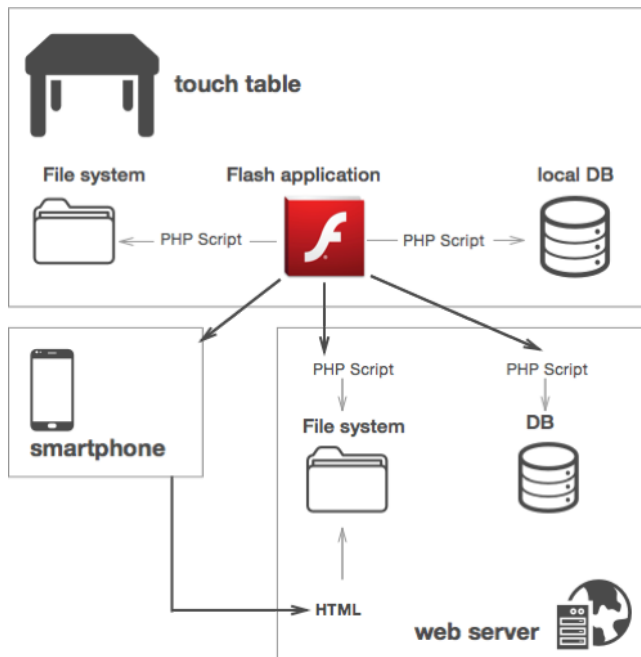


Fig. 8: Component diagram: The architecture of the interactive installation. It contains a touch table, smartphones and a web server.

The research about different technologies showed that Flash (Actionscript 3.0) together with the framework Open Exhibits (<http://openexhibits.org/>) for recognizing gestures is the system most suitable for us on the touch table. At the time of prototype implementation, Flash had a large community and is well-documented. Furthermore, we chose this platform for our comic experience application because of the experiences with Flash on multi-touch tables in previous projects concerning the stability and easy installation on Windows PCs.

Our application supports up to four simultaneous users and the process of drawing needs sensitive reactions by the system. The gesture framework Open Exhibits provides the advantages of predefined touch-gestures and the support of simultaneous touch events, which are needed to develop collaborative applications. The first step in the implementation phase was to build a clear object- and action structure, defining which data-objects should be used and which actions would be performed on those objects. A database contains all the data objects and their relations. This database is also used for our website, where the users may open their drawn images from home or on their smartphones.

IV. EVALUATION

Two user tests were performed: one was conducted in a laboratory setting (at an early conceptual stage) and one in the field (with a completed first release prototype). The study design and results are presented in the next sections.

A. User Study in Laboratory Setting

1) *Prototype*: The interactive prototype running on the touch table at this stage of the design study already included these functions: opening the drawing application via drag and drop interaction; selecting the brush and setting its width; drawing on the comic panel; erasing the lines; adding text and bubble elements and typing text into it. Based on a user-based usability test we evaluated the prototype to investigate (1) how effective the drawing application is and (2) how satisfying it is for the users to draw with their fingers on a multi-touch table. (3) Furthermore, the text-input method, in our case a soft keyboard (Figure 8), was part of the analysis. The aim was to find out how easy it is for visitors to type on a touch-based keyboard.

2) *Procedure and Participants*: 13 high school pupils (11 female and 2 male) at the age of 14 to 15 years participated in the user test. At this point of development the main functions of the application were fully developed and implemented on the touch table. The test equipment consisted of two 40 inch framed table-tops including infrared to discern the touch points and two DSLR cameras recording the interactions with the system and the users' feedback. During the observations handwritten notes were taken. The participants were supposed to complete a set of seven predefined tasks and were divided into two groups: one group consisted of single students working through the tasks and the second group were four students working together on four individual areas. Both groups faced

the same tasks to complete and did so simultaneously in two separate rooms.

3) *Study Design:* The tasks the students had to complete included: (1) describing what they see, (2) drawing a cat, (3) letting the cat talk, and (4) changing what the cat is saying. Due to the qualitative character of the study, the subjects were asked to fill out a questionnaire on how well they were able to handle the application and how much they enjoyed doing so at the end of the usability test.

Furthermore, a focus group discussion with all 13 students regarding questions such as: Did they like the application? Would they improve certain functions? Do they have general recommendations? was initiated to get a broad range of viewpoints and insights. During the test, the thinking aloud approach was followed [26].

4) *Test Results:* The results suggest that drawing with fingers on a multi-touch table is very effective and easy to use, though some of the students struggled to draw as accurate as they wanted to.

The suggestions of the questionnaire indicated that the drawing part is very satisfying for the participants. All students ranked the application between 1 and 3 (grades 1 to 5, 1 indicating the highest satisfactory level). They commented that they would try drawing on the table in the museum, as well. Some students also revealed that they like to be creative. Regarding the brush design and variety of colours provided, they expressed the wish for a thinner brush and more colour combinations.

The text-input via the keyboard (Figure 9) revealed some room for improvement: during the test it could be observed that participants had problems with typing on the keyboard. The touch areas were too small, causing the keyboard to close itself when they hit the drawing area instead. The subjects also called for a cursor.



Fig. 9: The improved keyboard design as a result of the laboratory test.

B. Field Study

The second user test was conducted on-site in the museum, testing the application in real world circumstances in the field. At this point, the development of the prototype was basically finished. Based on the previous prototype for the laboratory setting this prototype was improved and extended. The improvements included: one brush with more colours to choose from (8 main colours); collaborative drawing functionality; a keyboard adapted by resizing the keys. The application was extended by the functionality of reading comics.

This field study examined (1) how satisfying it is for the user to draw, (2) how effective the concept of collaborative drawing on a multi-touch table is, and (3) whether stories were being developed.

To record user behaviour and interactions remotely, we installed a webcam beside the touch table and used the Software *iSpy* [27] to adapt the recording time of the camera to the opening hours of the museum. We also implemented instrumentation functionality to log usage data while using the application (such as which tools were used, which stories were chosen, or how long drawing sessions took).

1) *Procedure and Participants:* The table was set up in one of the rooms of the museum (called Deix room) over a period of one week. Posters on the sides of the table explained that it was a university project, that visitors were invited to draw comics and that users would be filmed when using the table. These were the only explanations museum visitors received regarding the use of the table. A camera filmed the interactions of the visitors when using the table. When closing the application, a pop-up with a voluntary questionnaire appeared. In the background, we logged data to get more insights about the interaction behaviours of the visitors.

The test participants were a random group of visitors, regardless of age and media literacy, who attended the exhibition at the Karikaturmuseum museum in the time period of one week. The exact number of participants is unknown, as the camera that recorded the users was positioned in a way that guaranteed their anonymity. Overall, 185 sessions were captured.

2) *Study Design:* The camera was arranged at the side of the table, filming from high above. So, the whole table was in focus while the angle provided the anonymity of the visitors.

The questionnaire was structured in two parts: After giving their approximate age, gender and their reason for visiting the museum (or deciding not to answer), they could choose between different smileys (laughing, neutral, sad) to state whether or not they found navigating through the application easy, they instantly knew how to use the drawing tools, and if they liked drawing on the table.

User behaviour was also logged in the background. The following research questions were the basis for the logging functionality: (1) Which of the four comics based on a Deix drawing (“king of the cats”, “women on the beach”, “playing indians”, “hedgehog”) was chosen most often? (2) Did users close the drawing app before finishing their picture? (3) How many pictures were finished in total? (4) Which comics did they like to read? (5) During which times of the day was the table used? (6) On which day of the week was it used most often? (7) Do users prefer working alone over working in groups? These are some of the questions the log contributed answers to.

3) *Test Results:* Collaboration and Stories - Findings showed that users are more likely to work on a comic alone instead of in a group. Their favourite story was a story about the “king of cats”, but when drawing alone the story about

a “woman on the beach” was chosen most often. Concerning working in groups, we could observe that people help each other and work together rather than destroying the work of the other drawers. Even when people work separately on their own sketches, they stop to help users with problems in using the application.

Interestingly, the developed panels/drawings exhibited less elements of a comic, such as text boxes or speech bubbles. A few participants used a thin brush to write texts to complete their panel instead of using the text tool (Figure 10). Overall, within 185 sessions, visitors used text elements only every fourth session and every second session they placed speech bubbles on their drawings.

Reading Finished Comics: In the days of the field study, no comic was finished completely. Since only completed stories can be read on the table, the visitors were not able to flip through stories. Overall, the video recording showed that the interface design and interaction was clear and easy-to-use, though.

Participants: In the testing period visitors between the ages of 11 to 25 and 36 to 50 years attended the exhibition. The application was used by more women than men.

Questionnaire: The overall response to the drawing application was very positive. 48 of 60 visitors rated the drawing application as positive. Respondents were asked to indicate whether the tools (brush, text and bubble, undo) are immediately clear. 41 of 60 participants categorized the tools as very easy to understand and easy-to-use.

V. DISCUSSION

The findings of the two usability and user-experience studies can give some implications and experiences for the design of collaborative drawing applications with the focus on storytelling on multi-touch tables in art museums. The results seem to be consistent with other research as shown in the following sections.

Concept & Interaction Design: The interface of the drawing application was designed in analogy to well-known applications such as *Adobe Photoshop* or *Illustrator*. The tool palette is positioned on the left side of the interface, with the drawing area next to it. By tapping a tool, a menu opens and provides the different choices the tool offers. By using drag and drop or tapping on the selection of the text elements, for example, they appear on the drawing area. The video observations of the field study and the personal observation in the laboratory show that only few users prefer the possibility to drag and drop elements over tapping on an element and have it appear on the drawing area. The comic reading section is structured the same way; on the left, one can choose between the four different stories and next to the sidebar the presentation area is positioned. Based on the statements of the conducted questionnaires, and interaction behaviors of visitors as seen on the videos of both studies, we can state that this structure of the interface works well for a wide range of visitors.

The user studies showed that one brush is efficient enough as long as the thickness can be adjusted properly enough.

Regarding the text-input method we can only interpret the results of the study. 185 sessions were detected during the field study in the museum, but only 57 of the drawings were signed by the visitors and only few comic panels exhibit text elements or speech bubbles. This may result from the input method for text, using a keyboard known from the smartphone applications. So, we can confirm the results of Wigdor et al. [28] stating that text input on large multi-touch tables can be problematic and that more research besides Hinrich et al.'s [24] study to investigate new methods for textual input ought to be done.

The concept of collaborative storytelling in this specific context of the museum Karikaturmuseum Krems works well. We found some storytelling aspects in one comic, but there were no completed comics. As there are four different stories to choose from, it takes a while until one comic is completed. The number of panels resulting in a comic was defined as too high. We recommended a number of panels for a story of approximately 10 panels. A way to get visitors to complete comics quicker, and thus be able to offer the application's full functionality, could be to start off with only one story and have visitors unlock the other three stories by completing one story after the other, until all four stories are available. This would also force users to work collaboratively, which could then lead to have museum visitors interact more easily. In that way, we can avoid the problem that there are no comics to read on the multitouch table, as well. It is important to show at least a message saying that this area is empty until the predefined number of panels for one story has been finished.

Collaboration: Our findings show that users are more likely to work on a comic alone instead of in a group. So, we can confirm the results of Block et al. [29] and express the need to provide a meaningful single-user experience. But surprisingly, this phenomenon can be noticed differently depending on the topic of the story. Some topics are more likely to be drawn collaboratively than others. To ascertain why there is a noticeable imbalance in the stories with regards to visitors working alone or collaboratively, more research would be necessary.

Besides the known behavior of social learning and peripheral interest identified by Hinrichs and Carpendale [30], we could determine the fact that users help each other by giving hints or performing the interaction for their partners on their personal area.

Research Methods: The conducted research methods, the user study in the laboratory setting on the one hand, the user study in the field on the other hand, can be categorized as very useful. The early on user-centered research in the laboratory gave important insights on the problems of the interface and user behaviors while interacting with the drawing application on the multi-touch table. Here, we were able to discern that the concept of collaborative storytelling while drawing is effective and satisfying for users even early in the design process.

The second usability study in the field with video record-

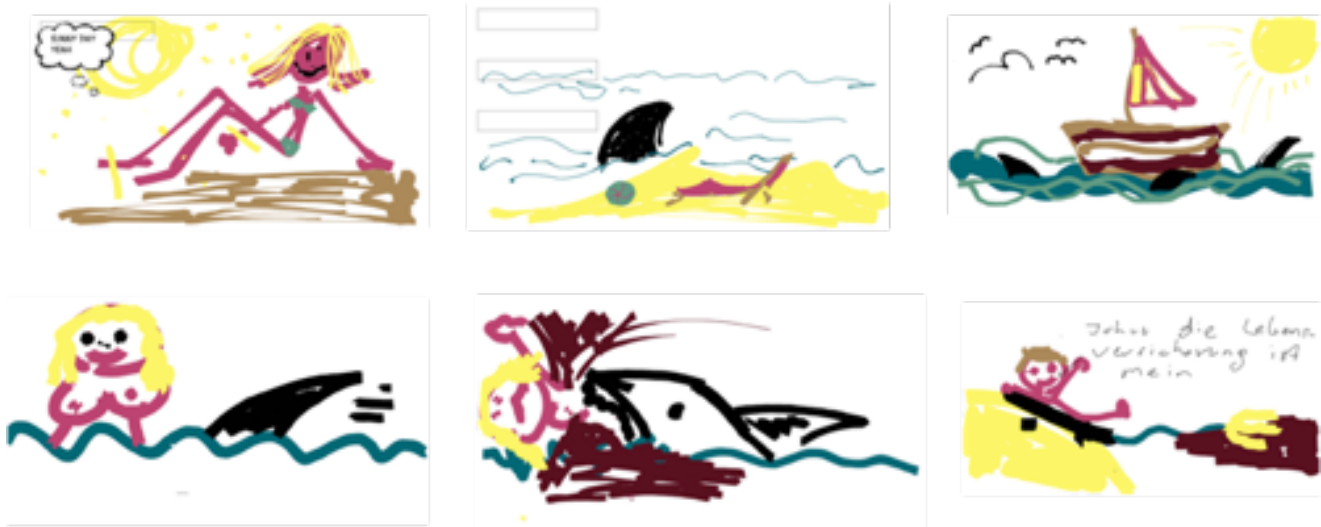


Fig. 10: Example narrative created during the field study.

ings, logging and a questionnaire provided different insights into the usage of the drawing application. The video recordings gave us the chance to identify the overall usage of the drawing application and insights into social interactions in groups or alone. To get more information of the visitors and their interactions the logging of the data gave us knowledge about the exact number of sessions, used stories and tools as well as the age of the visitors. So, the combination of video recordings and the data logging can be recommended as it is very useful. In upcoming studies we would integrate a personal questionnaire again, asking the visitors about their interaction with the interface to get more insights into the needs and wishes of the target group.

VI. CONCLUSION & FUTURE WORK

The presented study was designed to determine the effects of the integration of an application on a multi-touch table in the context of the Karikaturmuseum Krems. Thus, a drawing application based on a collaborative concept was developed and tested in the field and in a laboratory environment. The results show that there is large potential for introducing such kind of digital technology in a museum's context. The development of systems such as mentioned for collaborative drawing applications with a storytelling aspect to them for art museums introduces some challenges, such as:

Interplay Between Table-top and Smart Device: Concepts for multi-display scenarios that incorporate both large displays and small personal mobile devices have to be explored in depth in further studies. We approached this subject by giving visitors the chance to take elements of the museum's exhibition home, thus keeping them connected to the development of the stories, as well as the museum in general. Calling up a website on their personal smartphone is a step toward the multi-display trend defined in 2010 by Isenberg et al. [31].

Collaboration: Museum studies have found that people often visit exhibitions in groups [9], [32]. Yet, many museums offer elements where visitors work on individual tasks sequentially or parallel, but never collaboratively [31]. So, systems should provide aspects of collaborative work not only in the form of integrating large tabletops but also interaction concepts and game concepts for working in groups on one task. With our tool, we can introduce a storytelling approach for a drawing application with the focus on collaborative drawing, by allowing museum visitors to draw on their personal working area, but simultaneously draw in collaboration with other users.

In future research we plan to focus on identifying which aspects of the application work well in any museum, which are specific to a certain type of museum, and which only cover the particular needs of the Karikaturmuseum Krems.

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