



# Stories from the Empty School Desk: Places, Objects and Memories in Augmented Reality

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## ABSTRACT

*Stories from the Empty School Desk* is an educational project and experience based on the use of augmented reality and designed to raise the awareness of young generations about the dramatic events related to the persecution of Jews and the Italian resistance movement during Italian Fascism and the Nazi occupation of Italy. The project is characterized by the design of a temporary place of memory, the reconstruction of an Italian classroom of the 30s-40s, to be explored with AR technology. The AR experience was created with the collaboration of the high school's teachers and students, starting from information available in the historical archive of the school itself and other trusted sources. In the AR experience, visitors are engaged with objects, historical documents, and human silhouettes that populate the classroom. An evaluation study displays good results for several analyzed dimensions, including engagement and ethics.

## CCS CONCEPTS

• **Human-centered computing** → **Mixed / augmented reality; Contextual design; Interface design prototyping; Empirical studies in interaction design.**

## KEYWORDS

augmented reality, digital humanities, evaluation, prototyping, public history

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## 1 INTRODUCTION

The AR project *Stories from the Empty School Desk* was developed in the context of an educational activity targeted at improving young generations' awareness about Fascist Italy and Nazis persecutions against Italian Jews and the Italian resistance movement, with a particular reference to what happened in Italian high schools. AR technology was chosen for its capability of engaging young people and permitting a form of situated learning, connecting objects and environments to narrations.

The AR experience proposed in this paper stems from a collaboration between a local high school, whose pupils and teachers were discriminated and persecuted by Fascism and later also by Nazism, and the availability of its interesting historical archive and library, where we could retrieve official documents, photographs but also books and journals supporting the fascist propaganda and racist ideology. The project is based on the technical features of an AR platform, which is the result of three years of work under the name of *Remembering the City: Stumbling Stones, Memory Sites and Augmented Reality*. This platform was designed to support the awareness of historical events in an urban context by augmenting *stumbling stones*, small brass objects embedded in the cobblestones of the streets, and memory sites, mainly related to the persecution of the Jews and the fight against Nazi Fascism. Nowadays there are more than 70.000 stumbling stones, placed in different cities of Europe by the German artist Gunter Deming [12] for commemorating the victims of Holocaust. *Remembering the City*, fully described in [23], includes an authoring environment for composing augmented reality views and complementary web content and delivering it through a multi-platform mobile app. The platform includes also a support for geolocating the places that are part of the experience.

From a communication point of view, *Stories from the Empty School Desk* appears as a spin-off of the *Remembering the City* project, fully integrated in its app interface, as it can be seen by examining the dashboard presented in Fig. 4(a).

The AR platform was initially used in association with a storytelling model where each location could be hundred meters from the others and provided an independent narration, triggered by single objects (ie a brass stone, a plate).

This work aims to test the platform with a richer narrative model, anchored to a complex place characterized by the presence of many objects that can activate the narration. While the previous urban

experience operated a partial immersion in the history of different urban locations thanks to the presence of the stumbling stones, this work intends to fully immerse the visitor in the atmosphere of a school of the 30s-40s, by reconstructing the environment with furniture belonging to that historical period and populating it with historical documents retrieved from the school archives. From the point of view of interaction, this work tests the intersection of two different kinds of AR experiences: the exploration of a physical environment and the augmentation of printed documents, which are integrated into a seamless user experience. The narration model moves from single independent fragments accessed in different locations to a set of connected stories that the user is invited to listen to in a suggested spatial and thematic order.

Another goal of this work is to continue the experimentation, initiated in [23], with an authoring workflow starting from trusted sources and based on the work of students supervised by content experts. Because of the importance of the topics related to the reconstruction of the classroom, this work experiments forms of content control and refinement derived from the peer-review process, which is traditionally associated with scientific production and usually not adopted in a high school context.

Summarizing, starting from the initial motivation of engaging the new generations in acquiring an awareness about the tragic facts related to Fascism and Nazi persecutions, this work proposes a rich narrative experience that merges two different models of AR experiences and a content authoring path based on a rich historical archive and inspired by peer-review methods.

The rest of the paper is structured as follows: Section 2 describes the related works; Section 3 presents the high school involved in the project and its historical archive; Section 4 and 5 discuss the project concept and how content was created and validated; Section 6 describes the resulting user experience; Section 7 describes the evaluation study; Section 8 draws the conclusion.

## 2 RELATED WORKS

AR experiences are being developed in various fields, including education [22]. The aim of these experiences is two-fold. Firstly, to increase the knowledge of the users, and secondly, to increase their cognitive and emotional involvement. By following this partition, this section will be divided into two parts: a) learning; b) cognitive and emotional engagement.

As far as learning is concerned, the role of AR in education has been of paramount importance in transforming education. Several studies have pointed out that AR in education has the pedagogical potential to reduce cognitive overload by providing opportunities for learning in various ways: using learning by design [4], through generative AR learning objects [14] or focusing on creativity and critical analysis [8]. A number of studies have highlighted AR learning as a pedagogical tool for discovering and reading books [10] [11] [25]. It is important to note that most of the studies related to AR books have focused on pre-school and school-age children [1][6][29], on the interaction between children in reading together with the AR, and on the role of the parents. A project that is related to the topic presented in this article and that combines a paper book with an AR app is illustrated in [9]. Using the short novel *Tabacco Barn* by Chung Li-Ho, students can

read the content of Hakka culture using the AR app on a mobile device with a camera. They can focus on the images and receive augmented audio and video information to help them gain a deeper understanding of the Hakka culture minority in Taiwan. A somewhat similar approach was used for the young generations that are the target of the *Stories from the Empty School Desk* project presented in this paper. In spite of this, the project adds a novel focus on another segment of young people, high school students, and on a more demanding topic. Besides, interaction with printed documents is only a part of the experience: visitors are immersed in a place that is partly a replica of a historical classroom within the school, where the different documents are placed together with furniture and other physical artifacts.

Moving to cognitive and emotional engagement, several studies show the positive impact of AR in enhancing it during visits to historical sites [3][15][16]. In this context, Roth and Fisher critically reflect on how AR can create a positive collaboration between historians and developers to enhance and renew storytelling as a new expression of historical events [26]. In relation to this last aspect Azuma highlights AR's role as an enabling technology for creating new types of narrative media [2]. It is thoughtful to observe how this approach was used in the design and implementation of the *Stories from the Empty School Desk* project that is described in this article. In particular, in developing a new idea to stimulate curiosity and engage students in the AR experience, while facilitating their learning through increased cognitive and emotional engagement, the intertwining of historical research and the development of the AR interface with multimedia content was essential. Particularly in recent years, more studies and projects on Jewish history and the Second World War have been developed in the context of digital humanities, as some publications show [5][30]. A new educational project by the USC Shoah Foundation, called the *IWalk* app, is designed to provide an interactive on-site tours and virtual eyewitness testimony at the original historical site [13]. Aside from the projects mentioned above, we should also mention a 2018 project launched by the United States Holocaust Memorial Museum in Washington, DC, which lets visitors view some of the museum's exhibits through AR using a smartphone app. This pilot program, aimed at young students, involved around 80 students who learned about the lives of the Lithuanian villagers before their executions. These people are featured in the Tower of Faces, a three-story permanent exhibition section [18]. AR applied to Holocaust education is not new, as Challenor and Ma suggest [7]. Their research paper presents two studies on AR applied to the Holocaust. The first study was conducted with the Maitland Holocaust Museum [28], and the second with the UK National Holocaust Centre and Museum [17]. However, as demonstrated in [7], little research has been done on how AR can enhance the delivery or impact of Holocaust education. It should be noted that the projects described above, except for the *IWalk* app, were designed and implemented for museums. The digital and public history project *Remembering the City: Stumbling Stones, Memory Sites and Augmented Reality* [23] and the *Stories from the Empty School Desk* project described in this work are positioned within this research. However, rather than designing experiences for museums, both projects bring a different vision of Holocaust remembrance into the very urban spaces and a high school where the facts happened.

### 3 THE HIGH SCHOOL AND ITS ARCHIVE

The high school that was involved in the design and evaluation of this experience is located in the historical center of Venice. During Fascism, schools were the targets of ideological and racist propaganda conveyed through printed media and radio broadcasts. As a result, restrictive and discriminatory anti-Jewish legislation was progressively applied to Jewish boys and girls, leading to their expulsion from every Italian school after the autumn of 1938. This also happened in the school we've collaborated with, and the history of the expulsion of the Jewish pupils is narrated in the book *Il banco vuoto (The Empty Desk)* [27]. The book, written by Maria Teresa Segà, a historian, and a former high school teacher, describes the events happening in those years, starting from the story of the expulsion of Alba Finzi, a Jewish girl. A close classroom mate of Alba insisted that nobody should have occupied her seat after what had happened to her friend. Another story considered was that of Alessandro (Sandro) Gallo, an anti-fascist professor of history and philosophy teaching in the same school. Testimonies were taken from some of his students who recalled his passionate lessons against fascist propaganda. In 1942 he was arrested and exiled. In 1943 we found him again as a partisan fighter in the mountains of Cadore (Belluno), where he died at the hands of the Germans on 20 September 1944.

The high school features a very interesting historical archive that contains school records, report cards, school annuals, administrative directives, and photographs. Besides, the archive and library hosts collections of journals, like the racist *La difesa della razza* (The defence of the race) and *La radio nella scuola* (The radio at school) promoting the use of this media for propaganda.

### 4 THE CONCEPTUAL PROJECT

The goal of the project, as stated in the Introduction, was to increase young generations' awareness about the tragic facts that happened in the Italian schools of the 30s and the 40s. In particular, the project focuses on the people and the facts that happened in the school we collaborated with. The stories of Alba Finzi and Sandro Gallo became essential parts of the UX experience that we designed.

For what concerns the creation of the user experience, we started with the availability of the school historical archive and with the idea of telling stories associated with documents belonging to it. But to obtain a better immersion in the atmosphere of a high school in the late 30s, we also decided to rebuild the physical classroom environment, taking advantage of furniture that probably belonged to that historical period and that was still available in the school. The augmented reality paradigm was selected for its capability of recognizing objects belonging to the real world and associating content to them. This capability was used for activating context-specific narrations associated to the historical objects and other artifacts that composed the scene, for involving the visitors from an emotional and cognitive point of view. In addition, for the delivery of the experience, we decided to focus on personal smartphones, to encourage the use by the new generations.

From a conceptual point of view, the project merges into a single AR experience the exploration of a physical environment and the

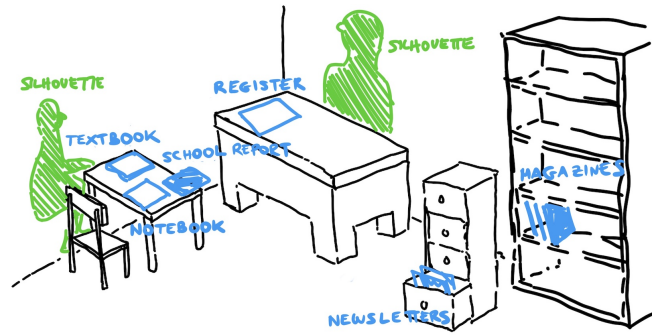


Figure 1: The preliminary sketch with the classroom and the specification of some active entities.



Figure 2: The final version of the classroom, populated with furniture, human silhouettes, documents and books; the capital letters suggest the sequence for the visit to the installation

access to a selection of printed documents, which usually belong to different categories of AR experiences, as mentioned in Section 2.

An early sketch of the design idea is shown in Fig. 1, which represents a preliminary idea of a classroom populated with furniture, printed materials, and silhouettes representing students and professors. This preliminary concept was matched against the real availability of historical furniture and archive documents for coming to the final solution displayed in Fig. 2, which also displays the final realization of the silhouettes representing the student Alba Finzi, her classmate Ada Lotto and the teacher Sandro Gallo. Regarding the archive documents, we could count on the collaboration of the historian that wrote the already mentioned *The Empty Desk* book. She was an invaluable support for guiding the students through the archive documents.

Fig. 3 shows a work session in the school library, with the historian explaining to the students involved in the experimentation (21 students aged 17-18) the meaning of the different historical records, journals, and their relation with the personnel and the students which attended the school at that time. This work was



**Figure 3: Work session at the school library**

of paramount importance for showing to students how engaging stories could emerge from old archival documents and for coming to a selection of documents to include in the reconstruction. The ambition of *Stories from the Empty School Desk* was to capture and communicate, through the AR app, the knowledge and the emotions that this teacher evoked from these silent documents.

Finally, concerning the narrative model, *Stories from the School Desk* moves from a set of completely independent narrative locations to a suggested sequence of visit. Fig. 1, examined from left to right, represents the initial idea of focusing first of all on the students of the school, then on the professors and finally on the propaganda communicated through different media. While the visitors are still free to frame the objects that compose in a different order, this sequence was maintained in the final solution and suggested as the preferred visit sequence (see Fig. 2).

## 5 CREATING CONTENT FOR THE USER EXPERIENCE

After the initial work sessions, we shared with students the preliminary sketch displayed in Fig. 1. Then, we asked them to compose short narrations, starting from the documents selected with the collaboration of the historian, the teachers and other humanists of the project working group. In most cases, students, organized into 8 working groups, were invited to use the first person in the narration, playing the part of people represented in the silhouette or referenced in the historical documents (e.g., the school records).

We explained to the students that each narration should have been enacted and recorded as an audio file, in Italian, and English, for supporting visits from foreign students (i.e., the school has agreements with other European and US schools for students' exchange programs). We explained that this file would have been automatically played, in the AR experience, when the visitors would have framed the associated physical object of the reconstructed classroom. Students were aware of the interface that would have been used for activating the content by the final users, because in the initial part of the collaboration we took them in an urban field trip for experimenting with the *Remembering the City* platform and

interacting with different stumbling stones and other urban objects. Because of this experience, the students could gain a full awareness of the interaction mechanisms of the mobile app. Besides, they could experiment with the visual structure of the augmented views and learn how their narrations would have been accessed from the platform, both in audio and hypertextual format.

Because all the project was based on the reliability of historical documents and content derived from them, we introduced the students to the peer-review process, which is commonly used in academic publishing for granting the quality of a publication thanks to the interaction of content authors and reviewers. We took inspiration from this methodology for proposing to the students a structured approach to the review of content that they were going to produce. While in this project reviews were not operated by peers but rather by humanists that were part of the project team, we maintained intact the core workflow of peer-review activities based on an initial submission of the content and following refinements based on one or more review cycles.

The humanists supervising the process had a previous experience with another group of high school students creating content for the *Remembering the City* platform [23], but the results were mixed because of the quality of the tool that was used (a WordPress plugin that was selected because we use this CMS for managing the hypertext part of the platform). This time we decided to manage the process with the Moodle platform, which features a specific module for content reviews. Besides, the Moodle platform permitted to have a single place where to share also all the historical materials, tutorials, and links to relevant online resources. This is something that usually can't be found in academic peer-review platforms, but we esteemed this as of primary importance for young students that are not used to this kind of process.

The 8 working groups of students that took part to the project were asked to work on the topic assigned. They received, as already stated, an initial support by the teachers and the other humanists involved in the project and then were asked to elaborate and upload in Moodle the content, for starting the review process. One or more iterations of the process were necessary to each group for coming to the final result, depending on the quality of the content submitted and the improvements requested by the reviewers. The final result of this phase was, for each group: a short narration released both as a text and audio file, an in-depth text released as a text file, a set of photographs and images of historical documents related to the topic, a full list of all the bibliographic references and sources (i.e., while most sources were part of the school historical archive, the humanists of the working group asked permission to the owners of external archives for using them in the mobile experience).

## 6 THE USER EXPERIENCE

The user experience proposed to the user was focused on the exploration of the reconstructed classroom and the objects that populate it, taking advantage of the mobile app that the visitor was invited to download at the entrance.

The classroom reconstruction has already been discussed in the previous sections, and Fig. 2 shows the environment and the different components that can be activated. A printed copy of this figure was made available to visitors for suggesting the sequence

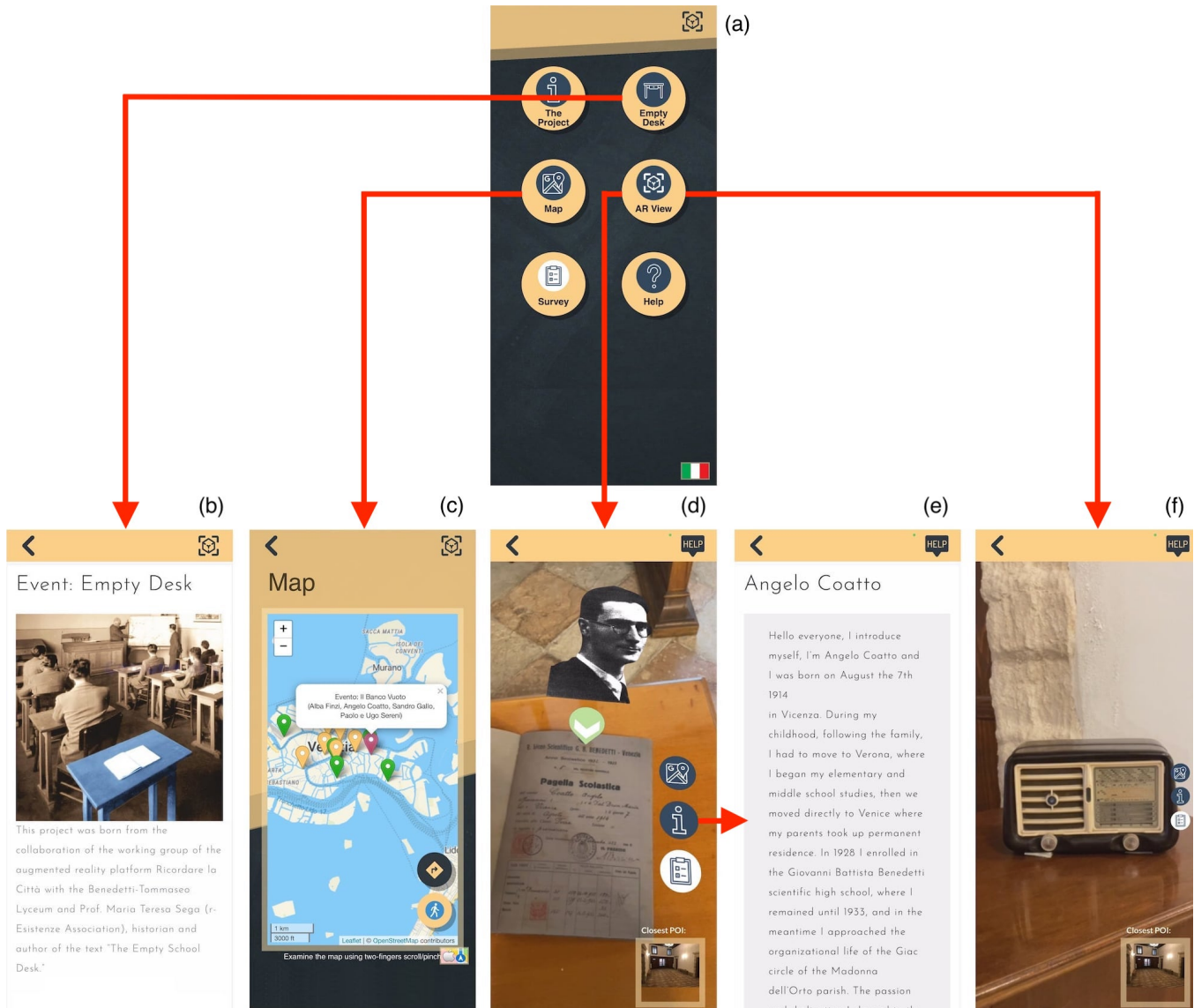


Figure 4: Interface (a) dashboard (b) intro to the project (c) map (d) AR view (e) alt. view (f) additional AR view

of interaction with the different objects that characterized the environment.

Because of the fragility of the historical documents, we realized copies of them for permitting visitors to manipulate them without risks. The human silhouettes were printed starting from photographs, but the faces were left intentionally blank to trigger the attention of the visitors exploring the classroom and invite them to frame them with their smartphones. This act, performed during the visit, metaphorically and operationally recovers from the oblivion the faces of the student and the teacher that suffered from Fascist persecution.

The digital part of the experience was designed and implemented taking advantage of the already mentioned *Remembering the City* platform. The app is available for Android and IOS and features

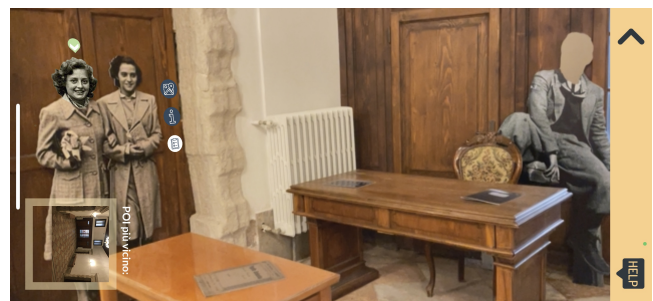


Figure 5: The classroom with the silhouettes of the students and their professor, as seen through the AR interface in landscape mode.



**Figure 6: The printed propaganda, as seen through the AR interface in landscape mode.**

an initial dashboard (Fig. 4(a)) for guiding the visitors through the different steps of the experience. After an introduction to the experience (Fig. 4(b)), the visitor can take advantage of the Map feature (Fig. 4(c)) for locating the site of the classroom reconstruction among the other urban places of memory, and reaching the high school with the integrated navigation tool. As a matter of fact, the reconstruction of the classroom was arranged in the main atrium of the high school to permit access also by external visitors. Once the visitor arrives at the high school, the visitor can switch to the AR view and explore the reconstructed classroom in full autonomy, framing the different objects that populate the reconstruction. Fig. 4(d) shows a typical AR view. When one of the available targets (i.e. the scoring record in this case) is recognized by the system, the audio file of the narration is automatically played for immersing the visitor in the mood of the experience. In addition, a set of buttons, usually placed on the right side of the augmented object, permits to retrieve: a textual version of the audio narration ((Fig. 4(e)), introduced for accessibility reasons; a survey to be filled in at the end of the experience; a map for locating the other places of memory in Venice. A green landmark pointing to real objects underlines additional insights that can be available by selecting the highlighted object. A miniature in the right bottom corner of the page reminds the visitor about the location s/he's currently in. Fig. 4(f) provides the screenshot of another augmentation, triggered by an historical radio device.

Fig. 5 and Fig. 6 show the AR interface in landscape mode, with the face of Alba resurfacing from the blank silhouette and a selection of propaganda journals. For what concerns the printed materials, we designed a more sophisticated model for exploring them, starting from the front cover. The audio narration obtained by framing the cover of the journal includes directions for retrieving interesting articles inside the journal itself and obtaining information with an additional augmentation. While most of the emotional augmentations are narrations recorded by students, in other situations, we experimented with different solutions for augmenting the engagement, like the fragment of the historical radio broadcast that can be accessed by framing the radio (Fig. 4(f)), or the animation of a chalk writing that can be accessed by framing the classroom blackboard. A sample of the experience has been made available as supplementary material.

## 7 EVALUATION

*Stories from the Empty School Desk* was opened in time for the 2023 International Holocaust Remembrance Day and was visited by high school students who did not participate in the content creation phase and by students from abroad who visited the school because of learning agreements. We took advantage of these visits for organizing an evaluation study and receiving feedback from students. The study was meant to assess different facets of the user experience to direct further work. After an initial assessment of the students' prior knowledge related to AR and historical facts, we investigated user engagement by taking advantage of the analytical definition by O'Brien et al. [19] and the following UES short form [20]. Because the UX was designed taking advantage of different components and media, we investigated their impact, both in terms of knowledge acquisition and emotional impact. Besides, because one of our primary concerns during the design of the experience was to reach the right balance between attractiveness and respectfulness of the approach, we asked the visitors feedback about this issue and the related ethical implications. Finally, because in a previous work we had started investigating the potential of the platform in terms of accessibility [24], we took the opportunity to have feedback about this issue.

We took advantage of the students' visits to organize evaluation sessions structured as follows:

- short introduction to the experience by one of the members of the project working group;
- technical assistance for installing the app in the students' smartphones; some devices were made available by the school in the case students did not have Internet plans (e.g., students from abroad);
- exploration of the environment; all the students were invited to explore the environment from left to right, moving from an initial focus on students who attended the school to their professors and then to the Fascist propaganda; students that visited the reconstructed environment were invited to frame the different objects of the classroom, including all the different types of documents that were made available; a printed poster with all the active areas of the installation was made available in the room in the case of difficulties to identify the objects to augment and for displaying the suggested sequence of visit;
- filling in of a survey focused on the main dimensions of the experience

A total of 29 students, 12 males and 17 females aged 15-19, participated in the evaluation. 19 students were Italian and 10 from abroad.

### 7.1 Questionnaire Structure

The questionnaire was designed as a set of closed and open questions related to different facets of the user experience. The closed questions were characterized by a 5-point Likert scale aimed at measuring:

- the initial level of knowledge related to AR mobile applications and historical events connected to the experience;
- the user engagement as the result of four main parameters (ie, focused attention, perceived usability, aesthetic appeal,

and reward) analyzed through the UES short form described in [20];

- the perceived value, from the point of view of knowledge acquisition, associated with different facets of the user experience (the access to the narrative audio track, the manipulation of historical documents, the interaction with the human silhouettes, the manipulation of the physical objects (ie, the blackboard, the radio, the desks), the access to hypermedia insights related to the augmented objects, the reconstruction of the classroom); the goal of this investigation was to assess the effectiveness of the different media and the impact of the physical setup for conveying knowledge;
- the perceived value, from an emotional point of view, of the same facets of the user experience described above;
- the balance between attractiveness and respectfulness of the approach;
- the ethical implications;
- the accessibility of the experience.

The questionnaire also featured a final set of open questions to give the visitors a chance to underline the main points of strength and weakness of the experience and to collect suggestions about possible improvements. A copy of the questionnaire is available in <https://mizar.unive.it/pietredinciampo/en/empty-desk-survey/>

**7.1.1 Ethical implications.** Among the different subsets of questions made to the young visitors, a special role was reserved to those ones focused on ethical implications. Engaging students, from a cognitive and emotional point of view, was one of the goals of the experience in order to improve the awareness of historical facts. At the same time, we were aware of the fact that AR is a persuasive technology, and therefore there were ethical concerns to keep in mind in the designing phase. Pase [21] underlines some issues that should be considered for assessing the ethical use of AR. We started from them by defining a set of closed questions useful to assess if:

- the novelty of AR had distracted the user from content;
- the content appeared credible;
- the user felt overly stimulated to interact and pay attention to the content of the experience;
- the user felt in control of the experience;
- the emotional involvement had caused discomfort to the user;
- the user was aware of the project's authorship.

## 7.2 Results

To check the consistency between the answers given by Italians and students from abroad, a preliminary analysis was carried out using t-tests to identify any significant discrepancy in the scores of the two groups. This investigation, which for the limits of space is not reported in this paper, shows that the scores of Italian and foreign participants are fundamentally homogeneous, with differences due only to the varying sizes of the two groups.

The results presented in Fig. 7 show the level of prior knowledge related to augmented reality and historical events narrated in the AR experience. Notably, most participants had a limited experience with AR applications, but were familiar with the historical events presented in the experience. Also the students from abroad had a basic knowledge of the events happened at the school because they

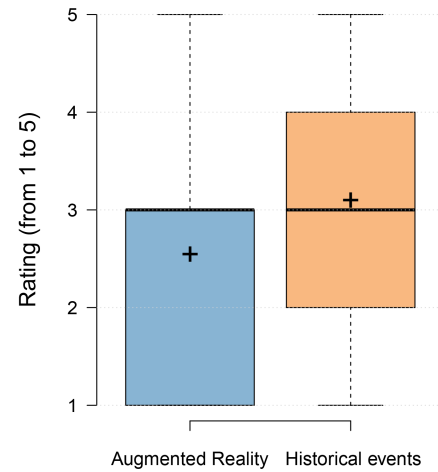


Figure 7: Prior knowledge.

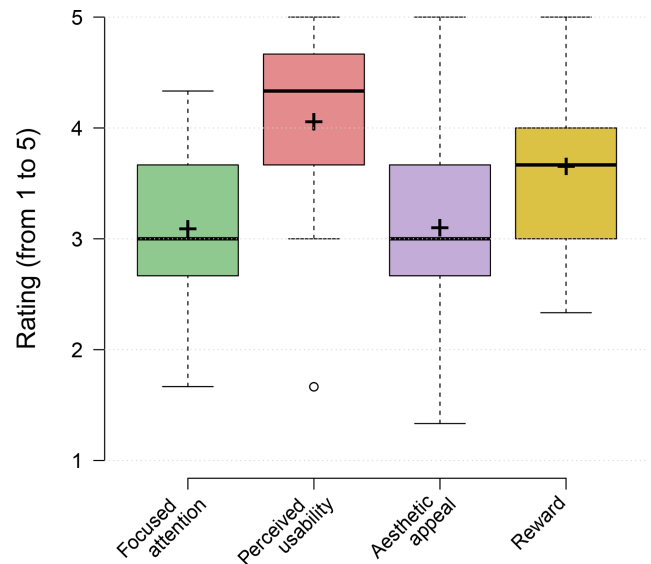


Figure 8: Focused attention, Perceived Usability, Aesthetic Appeal, Reward.

were part of an exchange program and had been made aware of them by their teachers.

Fig. 8 exposes the four parameters that define the O'Brien metrics for engagement. The means of results obtained for the different facets of the engagement are all above 3 points and are particularly good for *perceived usability* and *reward*. Participants rated the *perceived usability* of the experience the highest, with a mean score of 4.02. *Reward* received the second-highest score among the participants with a mean score of 3.62 (and three out of four quartiles beyond the rate of 3). *Aesthetic appeal* it's certainly the parameter that divided the users' opinions the most: with the largest spread of values in distribution and a mean value of 3.07. Similarly to aesthetic appeal, the mean value of *focused attention* scored around 3.06 with a narrower distribution of values.

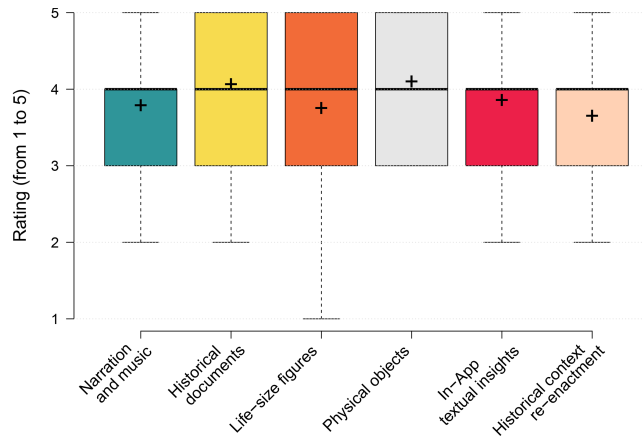


Figure 9: Facets of the user experience and emotional impact.

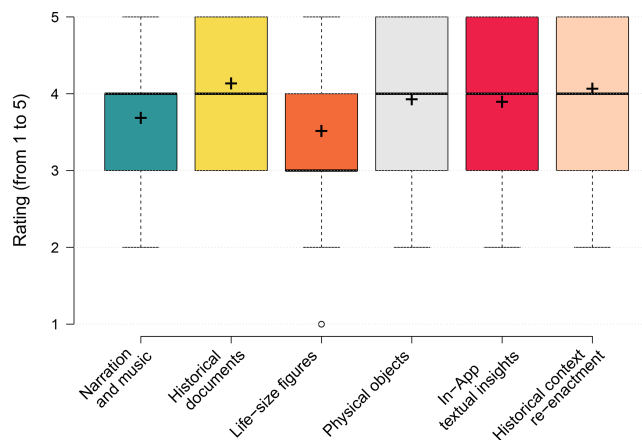


Figure 10: Facets of the user experience and knowledge acquisition.

Fig. 9 and Fig. 10 depict how the users rated the different facets of the user experience, in terms of emotional impact and knowledge acquisition. Both graphs present similar results with the first quartile matching the rating of 3 and the median equal to 4 for all the facets considered (with the only exception of the impact, in term of knowledge acquisition, for *life-size figures* (Fig. 10), whose median rated 3).

The components that had the major role for the emotional impact were the *historical documents* (with a mean value of 4.03), and the *physical objects* (mean value 4.07) embedded into the scene. Concerning *life-size figures*, while most participants assigned to them very high scores, others disagreed about their importance for the emotional impact, producing the largest spread of values in the rating. Concerning the most effective components for knowledge acquisition, the highest mean scores were obtained again by the *historical documents* (mean score 4.10), followed by the *historical context re-enactment* (mean score 4.03).

The results in Fig. 11 show that most students perceived the approach of the user experience as respectful, with only a single

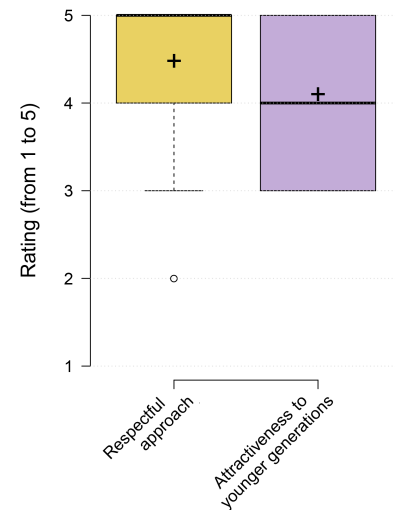


Figure 11: Respect and attractiveness.

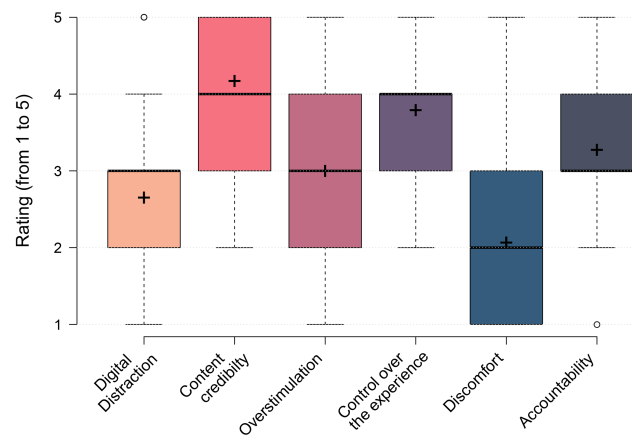


Figure 12: Ethical use of AR technology.

outlier assigning a score lower than 3. At the same time all the students ranked the experience from attractive to very attractive for young generations, with all the scores equal or above 3.

Fig. 12 shows the results for the six factors related to ethics that we derived from Pase [21]: *digital distraction* (smaller values are better), *content credibility*, *overstimulation* (smaller values are better), *control over the experience*, *discomfort* (smaller values are better) and *accountability*. Participants found the experience credible (*content credibility*), with most ratings concentrated on the higher quartiles (mean value 4.14 and median 4) and they had a good perception of the authorship who drafted them (*accountability*). In both cases, only one quartile scored below 3 points.

Most users felt in control of the experience (only one quartile below 3) and declared moderately low levels of discomfort (two quartiles above 2, but with a median showing a concentration around the value of 2). Finally *overstimulation* shows the largest variability in responses, with scores equally distributed from 1 to 5 and mean 2.97.



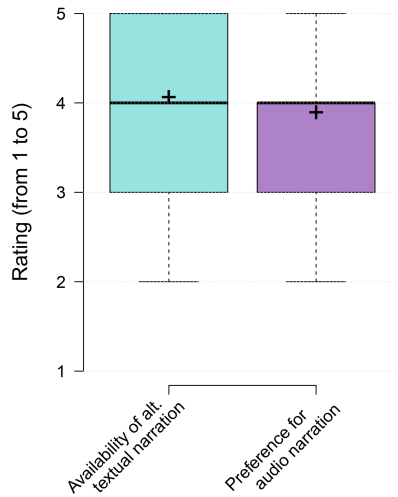


Figure 13: Accessibility

In Figure 13, the box plots provide the users' feedback about two related topics: the improvement of information accessibility through the availability of an alternative textual content and the preference for a given communication channel (i.e. audio narration vs. written text). The users assigned a high value to the availability of an alternative textual narration for people with hearing impairments and, at the same time, expressed a preference for audio narrations vs. textual content for non hearing impaired users.

In the very last section of the survey, the user was led into a series of open-ended questions that yielded valuable insights into the AR experience. Many students appreciated to be guided to discover and navigate a historically re-enacted classroom with physical objects and historical documents to interact with. Some of them underlined that this was an encouraging start to a new approach in education, and an opportunity for learning new notions using still unfamiliar but promising technologies. Complaints were mainly focused on technical issues, like the time needed for downloading the app (i.e. this was due to some issues related to the availability of the Internet connection), some stability issues, and the audio quality. The aesthetic appeal of the experience, though it gained a relatively good score in closed questions, was considered by some users as still worth of improvement.

### 7.3 Discussion

The survey gave a number of useful insights about the work done and its future development.

The answers related to the users' prior knowledge show a relatively low acquaintance with AR technology, which might surprise but can be explained by the age of the students, which are young but are not the target audience of the most diffused AR applications like *Pokemon Go*, very popular among younger children. Instead, the dissemination work done by the teachers, also extended to exchange students, led most students to declare a relatively good level of awareness about the historical facts that involved students and teachers during the 30s-40s.

The means of results obtained for the different facets of the engagement are all above 3 points and are particularly good for perceived usability and reward. Comparing the results with the previous evaluation [23] of the *Remembering the City* platform, we noticed improvements in all the parameters, including aesthetic appeal. This can be explained by the lessons learned in the previous design activity and the additional care in creating and polishing content for the experience. Another explanation is the availability of a richer narrative structure and a more immersive environment. While small urban objects represent an important testimony of past events but are single artifacts immersed in a contemporary landscape, *Stories from the Empty School Desk* tries to recreate a sample of a complete physical environment, populated by a large number of testimonies from the past. An interesting result is the score obtained for reward. Even though students already had a basic knowledge of the historical facts, they deemed the experience as rewarding. Again, the narrative structure and the recreated environment were probably the reason for this result.

The results related to the different components of the experience (Fig. 9 and Fig. 10) outline a positive role for all of them. Higher scores assigned to the availability of historical documents and other physical objects outline the impact of the physical side of the experience, which was one of the features that characterized this project and worked as a trigger for accessing narrations. Not surprisingly, textual insights accessible from the AR views obtained very high scores for easing knowledge acquisition.

Also in this experience, one of our primary concerns was to design an attractive but respectful solution. The users' feedback displayed in Fig. 11 suggest that the result was compliant with this initial goal.

The results related to ethics show that AR, a persuasive technology, was used in an appropriate fashion (Fig. 12). The students perceived the historical information acquired through the experience as credible, and they had a good understanding of the authorship. This was probably due to the good work done with the sources and the accurate references to them that were included at the end of the textual descriptions. Besides, the possibility to access and manipulate copies of historical documents coming from the school archive probably enhanced further the credibility of the related information. The novelty of the experience related to the use of AR technologies didn't cause a high level of distraction from the content. High scores related to control and low scores related to discomfort suggest that the design of the access to the physical environment and the digital interface permitted the young visitors to keep their own pace in exploring the environment without being forced into time and space. Scores related to overstimulation, as already mentioned, showed the largest variability among the different parameters that we have considered. The hypothesis is that the recreation of a physical environment in the same school where the tragic events happened probably had a relevant impact on the part of the students that felt overstimulated by being immersed in this place of memory.

Finally, results related to accessibility show that young generations are aware of the importance of accessibility, but at the same time, people that are not hearing impaired prefer audio narrations, probably because they are more engaging than the textual counterpart. This suggests designing an interface that provides content

using both communication channels, taking care of different situations and preferences.

## 8 CONCLUSION

*Stories from the Empty School Desk* was created in the context of the initiatives organized for the International Holocaust Remembrance Day to increase young generations' awareness about the tragic facts that happened during Italian Fascism and Nazism. While in the previous development of the platform *Remembering the City* we had anchored the narration to distant small objects embedded in places belonging to today's world, in this work we tested a sequential narration anchored to a place nearly completely defined by objects of varying scale belonging to the past. The evaluation made with students confirmed the experiment's success from the point of view of emotional and cognitive involvement, with good results also from the point of view of ethics.

As stated in the Introduction, this work experimented with two different types of augmentations, starting from the environment and from printed documents, that usually are associated with different types of user experience. In this experimentation the room and the bigger objects created a context. The documents, the silhouettes and small-scale objects completed the historical reconstruction. Overall, the potential of each category of physical objects was enhanced by the other one. This was confirmed by the high scores obtained for both these categories, in terms of knowledge acquisition and emotional impact.

We must also point out that the novelty of the experiment was also related to the age of visitors that were invited to interact with the printed documents. As reminded in Section 2, most studies related to AR books are focused on preschool and primary-school children, while the impact on high school students is less explored. And this work outlined, for high school students, the importance of AR books and physical objects for learning.

From an educational point of view, the AR experience has permitted us to share a selection of documents from an exciting archive, which usually is difficult to consult for issues related to the preservation of the documents themselves. With low-cost technologies, it was relatively easy to create documents reprints that were good enough to engage the students, providing a better alternative to anastatic reprints that are sometimes made available by institutions, but are costly and, above all, usually are not associated with a context. These low-cost reprints had the merit of making the visitors aware of the existence of the school archive, stimulating further interest in the full set of documents available inside of it.

The project was also another occasion for experimenting and refining the workflow of content production initiated with the *Remembering the City* platform, granting at the same time, technical independence for most of the operations needed to create the content, and quality of results.

Overall, the results achieved in this experimentation suggest to continue the research in two directions: the integration of environments and documents for creating integrated AR-based rich narrative experiences and the refinement of a content authoring model inspired by peer-review for supporting different types of audiences and situations.

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