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Massive Remote School Trips: A Case Study

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ABSTRACT During the height of the CoViD-19 pandemic in 2020 and early 2021, schools throughout Europe have been closed for several months, leaving teachers with the responsibility of providing distance learning through video conferencing and remote-presence systems, while parents were scrambling for appropriate tools and support. School outings have also suffered from the limited mobility of students given by stay-at-home orders and other restrictions. In this paper we present a set of technologies developed to reproduce the school trip experience, allowing students to stay at home or in school and requiring only a Web browser and Internet access, while integrating communication tools that allow participants to actively be engaged in interactive lessons and educational experiences. In 2020 the tool has been used during the ''CodyTrip'' event, a two-day visit to the town of Urbino, attended by more than 15.000 students, followed up with a series of events in 2021 with over 115.000 participants. Results from the pilot events show very high engagement and demonstrate the feasibility of organizing online visiting experiences with massive participation without compromising the perceived interactivity of the proposed activities, which can be equally engaging for different audience demographics. Findings also suggest that this solution may be adopted not only as a contingent substitute for traveling during the pandemic, but as an effective tool to widen the scope and appeal of cultural tourism.

INDEX TERMS Coding, computational thinking, CoViD-19, distance learning, educational technology, virtual tourism.

I. INTRODUCTION

On March 11, 2020, the World Health Organization (WHO) declared CoViD-19 as a pandemic, after months of growing global concern. Schools in Italy had been closed since March 4th, followed by a generalized lockdown on March 12th. Since then, schools have been going through a series of closures and re-openings, with mixed reactions from the public opinion [1]. Physical school attendance has been shown to be a major factor in CoViD-19 incidence, both in the US [2] and in Italy [3].

Most educational institutions, of all levels, rely on traditional teaching methods such as face-to-face lectures in the classroom. The sudden ''digital transformation of everyday life'' [4], which required to deliver the same educational courses through online video conferencing software or dedicated distance learning platforms, has significantly impacted the performance of students and their capability of completing the standard courses, while stressing existing technological barriers and digital divides. This shift has significantly challenged educators in adapting classes and courses to the all-digital scenario [5], [6], causing an increase in stress, anxiety, and depression [7]. In addition to overburdening teachers and students, many aspects of school attendance have been severely impacted, including social interaction, peer accompaniment, and participation to field trips, all of which constitute a major part of the scholastic experience [8], [9]

In an effort to support educators and parents in this scenario, we have performed a large-scale experiment organizing massive interactive visits to several cities around Italy, with a custom technological setup used to allow students to participate remotely while keeping them engaged during the school trip. In this paper we aim to determine whether this approach proved satisfactory in different usage scenarios, thus answering the following research questions:

RQ1 Do remote school trips provide satisfactory experiences, both for students and educators?

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RQ2 Do remote school trips have a positive impact on the schooling experience, in terms of teaching inputs, perception of digital technologies, and school/family relationship?

RQ3 Can remote school trips be adapted to a wide range of different requirements and participation conditions, due to socio-economic, technical, and public health circumstances?

Before discussing the experiment, we present a brief introduction on distance learning and virtual tourism, which show applications of similar technologies for educational and touristic purposes, and computational thinking, which was the main topic of the school trips organized during the experiment.

A. DISTANCE LEARNING

The possibility of completing an educational course without being physically present at a school, be it through mail correspondence or the increasingly ubiquitous Internet access, has been available for several years. Online education has traditionally been considered as an alternative for adult learners, who are unable to physically attend higher education courses. However, it is the CoViD-19 pandemic that has forced the world to adopt distance learning at an unprecedented scale [10].

Distance learning can provide several advantages, for both students and educators, which have been appreciated even in non-pandemic crisis situations, such as when handling the impact of natural disasters [11]. For instance, online teaching can provide student-centered and interactive programs, which are designed to fit the specific requirements of the students and to integrate their immediate feedback. Also, online classes provide flexibility, allowing learners to plan their attendance in terms of time and location, encouraging independence and releasing the potential of blended learning or flipped classrooms [5].

On the other hand, even the best online tools hamper the communication between learner and educator, when direct contact and human touch are mostly lost. Educational institutions are the center of social activities and interactions for most young learners, which are unfortunately left out in an all-digital scenario. Both students and teachers show different levels of confidence and capabilities with the electronic tools they are confronted with, which require at least some level of digital competency [12]. A lack of these competencies can result in frustration and discouragement. Also, underdeveloped countries or regions plagued by the digital divide may find it more difficult to effectively switch to communication platforms that rely on broadband Internet access [2].

B. VIRTUAL TOURISM

Tourism reported massive economic losses in 2020, because of the pandemic-related travel restrictions, and long-term effects are difficult to predict. Gössling et al. argue that the pandemic raises several questions on the vulnerability and sustainability of the tourism industry, while also suggesting that there are opportunities in major structural and transformational changes to the global tourism system [13].

Virtual tourism, which promises to deliver high fidelity simulations of any conceivable human experience within the safe and comfortable bounds of the individual's own home, has been envisioned for some time both in speculative fiction and in literature [14]. But far from being constrained to conjecture alone, over the last years virtual tours have started to gain traction because they require relatively little investments, they facilitate educational experiences, and they allow visitors to appreciate an attraction's tangible and intangible qualities. Many prominent museums (such as the Louvre in Paris) have adopted virtual tours to allow the public to enjoy part of their collections from home [15].

Some of these virtual tours may make use of Virtual Reality (VR) setups (which usually entail a head visor to fully immerse the viewer) or Augmented Reality (AR) systems (which combine real and virtual sensory inputs) to provide their experiences. In a survey by Beck et al., several VR-based tourism setups are described and separated into 3 categories: non-immersive, semi-immersive, and fully-immersive, based on the size of the screens on which the experience is delivered and the degree of immersion provided (i.e., ranging from standard computer screens with non-interactive pictures and videos to 360-degree real-life content displayed in a VR headset). The authors of the survey also argue that virtual reality is rapidly becoming an apt instrument to deliver innovative tourism experiences, since it allows enhanced information access, it can entertain and educate users, it is more accessible than physical tours, and it may help preserve heritage sites that are prone to damage by visitors [16]. Guttentag also cites planning and management tasks (for tour operators) or marketing purposes to the set of possible tourism-related VR applications [17].

According to Spielmann and Mantonakis, these tours distinguish themselves from standard video streaming experiences in three major ways: a) they go beyond passive viewing experiences and require participant-controlled interactions, b) they offer a unique and realistic perspective, c) they allow a form of telepresence or viewer immersion, leading to an augmented experience of the tour's subject [18].

Virtual tours have been proposed, for instance, as a learning environment specifically targeting computational thinking skills, within a virtual reality environment built using Unity and Vuforia [19]; a territorial marketing tool allowing e-visitors to explore specific locations and receive updated information using mobile devices and Oculus [20]; to provide a simulated 360-degree tour of the Capitol building in the US, showing that the experience can indeed be compared positively to real-life visits, in terms of several parameters, among which spatial presence and emotional engagement [21]; as means to provide remote museum visits for older adults [22]; or for immersive field trips in elementary schools with a dedicated VR headset [23].

However, the pervasive adoption of digital instruments to deliver leisure activities, such as virtual traveling, may raise the common fear of adulterating human experiences in a way that affects socio-cognitive behaviors, causing the *loss of presence* and the *alienation* of participants. As argued by Harmon and Duffy, there is a concern as to how the omnipresence of digital technologies contradicts the essence of *purposeful engagement* in leisure, which may lead to decline of psychological well-being [24]. Tribe and Mkono propose the term *e-lienation* to indicate the negative consequences of ICT on tourism experiences. While their research focuses on the encroachment of ''smart''-tourism into traditional traveling experiences, the same considerations apply to fully-remote tours [25].

In a recent study by El-Said and Aziz, it was shown that in choosing whether to attend a virtual tour or not, characteristics related to the tour itself (accessibility, informative content, and interactivity) are deemed more important than travel restrictions and risk-perception of the tourists, thus reaffirming that while virtual tours are particularly popular during crises, they have a potential that goes beyond that specific use-case [15]. To quote Eco, it remains to be seen whether the virtual experiences will be provided in order to *increase* the desirability of the original or to *supplant* the need of the original [26]. In both cases however, as technology improves, it is likely that virtual tours in general will not only be imitations of real tours, but also desirable experiences in of themselves [14]. Other research findings also stress that virtual tourism can be a valuable complement to mass tourism [27].

C. COMPUTATIONAL THINKING

Over the past years there has been a growing interest in the teaching of computer science-related concepts and methodologies in the classroom, for students of all ages. Problem-solving, abstract reasoning, and perspective-taking are only some of the abilities that can be taught through the basics of computer programming, which is increasingly recognized under the umbrella term ''coding'' or ''computational thinking'' [28]. Coding literacy is now recognized by educators and theorists as a crucial skill that brings benefits to all areas of learning in an increasingly digital world [29].

Many large-scale educational initiatives have been promoted with growing urgency during the last years, with the aim of promoting coding as a paradigm adopted across the learning curriculum even for early learners. Hour of Code (code.org) and Europe Code Week (codeweek.eu) are the most popular among several coding campaigns that exist world-wide. It is understood that an early exposure to computational thinking will provide students with a better understanding of pervasive technologies and fundamental digital skills, stimulating interests in the fields of science, engineering, technology, and mathematics (STEM), while attempting to compensate the gender inequality issues that surround them [30]. In light of the effects of the CoViD-19 pandemic, digital and online skills might indeed become vital, both for educators and students, if distance learning technologies will become a more permanent teaching modality for higher education [6].

In this context, several tools, paradigms, and games have been developed in order to support these efforts in the classroom or individually. 'Unplugged activities' in particular, which do not require electronic devices and that are fully inclusive from a technological standpoint, have been shown to improve coding skills and motivation in early education [31]. Among these, Bogliolo proposed a series of language-neutral cards, coded with simple icons and colors, to represent generic movement instructions on a grid, in order to mimic the common grid-movement style of coding games (also seen online, for instance on Code.org). These cards provide a basic rendering of essential coding constructs, allowing players to both act as programmers and as interpreters [32]. The cards also allow creating more complex sequences of code, with the addition of repetition and conditional cards. Published under the name of ''CodyRoby'', the game is available under a Creative Commons license and has been adopted in a variety of other games and interactive systems [33], [34], spanning the range between fully-unplugged and online activities.

II. METHOD

A. CASE STUDY

In this paper we adopted an experimental approach to verify the feasibility and impact of large-scale remote school trips, in order to respond to the research questions previously defined as RQ1, RQ2, and RQ3. First, a custom technological tool was developed, providing the means of delivering a fully-online school trip while retaining some of the interactive aspects of the experience. A pilot event was then carried out, performing an educational coding-themed remote tour in Urbino (Italy), developed for students unable to take part in traditional tours because of safety measures, stay-at-home orders due to the CoViD-19 pandemic, or any other reason, including socio-economic ones.

In the following sections, we will describe the enabling technologies that were developed and adopted for the pilot event and outline the means of data collection and analysis adopted for the case study. Following the initial pilot event, other events have been organized, which were also observed in order to collect additional objective data.

1) ENABLING TECHNOLOGIES

The remote tour system adopted in the pilot event is based on the physical presence of one single *tour operator*, possibly accompanied by a small number of people for support, who performs the actual touring on location. The live visit is recorded using consumer-grade video instrumentation (i.e., a recent smartphone) capable of live streaming its output through a live video platform (i.e., YouTube). Participants connect to the live virtual tour by using a special *visor software*, called ''ActiveViewer''. This software is implemented as a Web application (based on Google Flutter), which allows

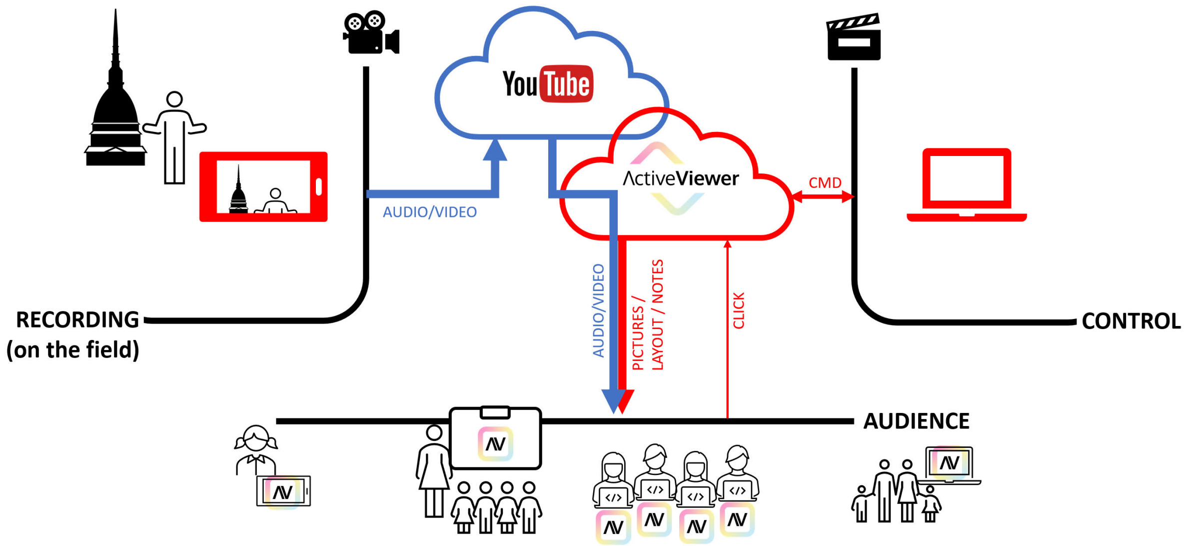

FIGURE 1. Overall architecture of the "ActiveViewer" visor and the data flow of an interactive remote tour.

participants to easily connect to the live tour by following a link using any modern Web browser, and provides a series of interactive features that allow active participation and collect feedback from the audience.

The full architecture of the system is shown in Figure 1. The upper-left area shows the actual tour operator, recording the visit on the field. Audio and video from the operator are streamed to the video streaming platform. The audience may connect through a variety of different setups, thus accessing the ActiveViewer visor, which embeds the YouTube video stream. The live video is delivered directly to the audience, decorated by visual elements provided by the visor, such as additional pictures, graphical layout elements or overlays (such as notifications or text), and interactive tools (such as buttons or clickable images). Feedback by the audience is delivered to the ActiveViewer visor, which is actively controlled by one or more administrators in the 'control room'.

Since ActiveViewer is intended for multi-user watching, where multiple participants share the same screen (for instance, for young students watching while in class or for student families at home), the visor prompts participants to provide the number of watchers that are connecting from the specific device. ActiveViewer keeps track of the live audience by providing the count of individual devices and the sum of audience members connected through all devices, in order to provide a real-time estimate of the actual audience.

Each participant group (i.e., each single device) is uniquely identified by ActiveViewer. The system generates a short **unique user ID** for each device, storing it in the browser's local storage cache. This allows users to resume their previous sessions even if they close the browser and reconnect to ActiveViewer. Each unique user is connected to an **audience count** set on first connection (as described above) and a **points count**. Points can be collected during the tour in order to award participation and correct answers provided during quizzes and interactive sessions.

The ActiveViewer screen for participants can show video (taking over the whole screen or centered), optional images, notifications, and several interactive elements. Sample configurations are shown in Figure 3, 6 and 5, which include video, images, and interactive elements. The dashboard allows administrators to update the tour's state, selecting one of the preset layouts, as shown in Figure 2. The screen also includes an overlay, to indicate that the event is being watched through ActiveViewer (i.e., the sidebar on the left displaying the event's name), and a "live" indicator on the top right, signaling that the video shown is streamed live.

As **interactive elements**, ActiveViewer supports the following modes:

- **Three-button polls:** When active, three buttons are shown on the bottom of ActiveViewer. The buttons are yellow, green, and red (from left to right), following the color-coding defined by the CodyRoby game, where yellow stands for 'turn left', green for 'advance' and red for 'turn right' [32]. While these buttons are, by default, designed to be used for coding exercises and games (as shown in Figure 3), they can be adapted for any use where a simple multi-option poll is required (asking for directions, for an opinion, etc.). Button polls can be used in the following modes:
  - *Single-shot:* Each device is given one single tap on a button. Once the button has been tapped, the poll is over.
  - *Weighed single-shot:* Like above, but each device has a weight given by its audience (i.e., a tap from a device representing 10 users counts as 10 taps).

FIGURE 2. The set of possible ActiveViewer configurations, showing various layouts with video and/or picture overlays.

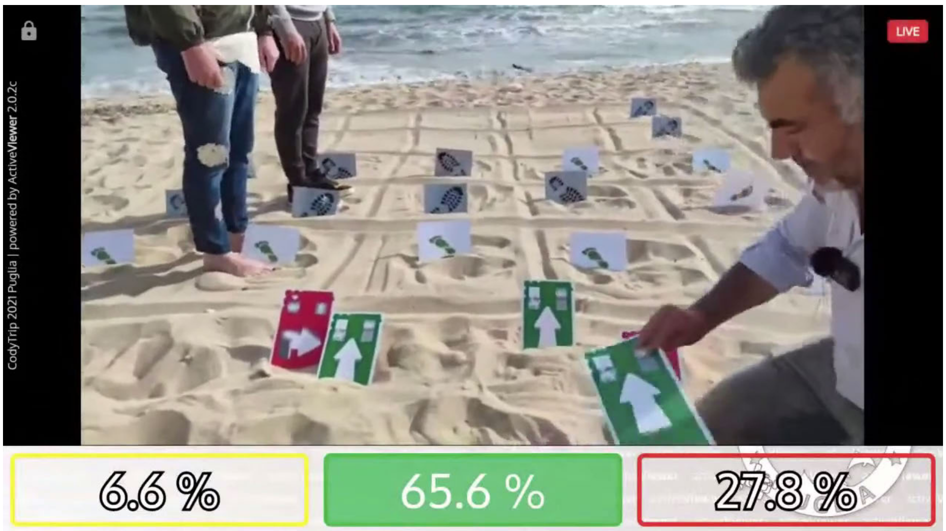

FIGURE 3. The ActiveViewer screen as seen by participants, during a live coding session on the beach.

   - *Single-shot with quiz:* In this case the administrators provide a 'correct' answer. Tapping on the correct one awards the user with a set amount of points.
   - *Multi-shot:* Unbounded clicks per-device, can be used as a clicking-game where the quicker clickers win.
- **Image polls:** These polls can be activated over any image. Users can then freely click on the image. All clicks are collected using normalized coordinates and are then displayed as an overlay. Just like the three-button polls above, image polls can work in *single-shot* and in *multiple-shot* modes, allowing users to tap only once or a limited number of times. Image polls can also be used in the following modes:
   - *Free:* Users are free to spend the allowed number of taps anywhere they want.
   - *Weighed:* Like above, but the size of the user's tap shown on the image is proportional to the audience they represent.
   - *Zoned:* The administrator sets a number of 'zones' within the image (in rectangular shape). Taps by the users are only recorded if they hit one of these zones. The system counts the number of taps on each zone and can display the results graphically (an example is shown in Figure 6.

ActiveViewer also collects **usage statistics** during its use. Each connected client notifies its presence once every minute, updating its 'last seen' timestamp. Every three minutes, the back-end system goes through all clients, checking for connected users (i.e., users whose 'last seen' timestamp is within one minute in the past). This allows the system to compute the number of connected devices and the total size of the connected audience.

Additionally, ActiveViewer can generate **participation certificates** once the event is over. While connecting to the viewer is anonymous per se (in order to protect minors and user privacy), users have the opportunity of claiming their participation, tying their identity to the unique session ID, which will give them access to a printable certificate that includes their name, the event's title and logo, the number of participants that connected to the event within the same session, the total amount of minutes watched, and the amount of points collected.

B. RESEARCH CONTEXT AND SAMPLE

The ActiveViewer system for remote tours was tested in a large-scale pilot event, called "CodyTrip" and held on December 10–11, 2020. The event was proposed to teachers of primary and secondary schools in Italy, for children between 7 and 14 years, as a stand-in for traditional school trips (which were impossible at the time because of the

TABLE 1. The two feedback surveys that were delivered to participants after the event, in the form of Google Forms questionnaires.

Survey		User identity	Target
S1	Participant survey	Anonymous	Pupils, teachers, parents.
S2	Teacher survey	Linked to EventBrite registration	Teachers.

TABLE 2. Number of participants as registered to the EventBrite event, by age and group size.

Age		Group size	
6–	21	1–10	36
7	54	11–20	350
8	65	21–30	269
9	137	31–40	26
10	171	41–50	18
11	94	51–100	16
12+	173		

generalized travel restrictions) and as a focused experience centered around digital technologies, computational thinking, and the power of imagination.

Participants (teachers with their classes, school directors, individual students or educators, and parents of students) did register spontaneously to the event, by signing up to an EventBrite event. Registration was completely free of charge. Participants were approached mainly through the endorsement by *CodeMOOC Net*, a non-profit association of Italian educators and school teachers interested in the adoption of coding as a teaching methodology. The event was promoted through the social channels of the association, among which the Facebook group "Coding in your classroom, now!" with over 36,000 registered users. It was not promoted otherwise, except through word of mouth. No incentives were provided.

The pilot event saw a total of 15,075 participants, registered as 715 groups, from 345 cities across Italy (as shown in the poll in Figure 4). Registered groups showed an average age and a group size distribution as shown in Table 2. Beyond class groups registered by their teachers, 462 individuals and 143 families also registered through EventBrite. The CodyTrip Urbino event ran from 10 AM of December 10 to 12 PM of December 11, 2020. Participants were invited to join the single segments of the tour's program in different ways: in class, if possible and if during school hours, at home while in a video conference with the rest of the class, at home together with their parents, or individually. Participants could also pick and choose which segments to follow, based on their existing school schedules or preferences.

The **program** of the remote tour closely mimicked the unfolding of a standard school trip and participants were invited, when preparing their remote visit, to try to reproduce the journey to and from their destination. After their 'bus trip', participants were greeted by their tour operator on location, at 10 AM. A series of visits followed, including a visit to the University Library, the Ducal Palace, Christmas lights through the streets of Urbino, and Raphael's birthplace, in addition to a live and interactive coding session. These tour segments, which in some cases would allow participants to visit places otherwise unreachable, were generally organized like standard visits on location, with the help of local guides. The program was completed by a set of supplementary activities, focused on recreating the feeling of a real tour, such as virtually dining together, arriving at the hotel and picking rooms, goodnight story reading, and 30 minutes of physical exercise on the morning of the second day of tour.

One of the core segments of the event was the **interactive coding session**, which allowed participants to join a massive online programming game, aimed at teaching them the basics of programming and code interpretation. The interactive coding session of the event was provided as a challenge between the local tour operator (and their assistants) and the audience. This two-sided challenge, akin to popular grid-based games as seen on *Code.org*, made use of standard color-based action cards [32]. The audience and the local operator took turns, picking an action card from a set of possible choices, which would then be executed by a 'robot' (i.e., a local participant moving on the grid as instructed by the cards). Actions for the audience-controlled 'robot' were picked using ActiveViewer's three button mode, allowing participants to vote for a specific card. Figure 3 shows a moment of the coding challenge, where the majority of audience members have picked the green card (clicking on the green button in the center) and thus making their 'robot' move forward on the grid. Albeit remotely, the session follows the large-scale coding event template as presented by Bogliolo et al. [35]. Other ActiveViewer features were used to further enliven the virtual tour, for instance asking for frequent user feedback through three-button polls (allowing the audience to choose the next destination when sightseeing or whether to do something), polling for user satisfaction at the end of each tour segment, and providing several side-activities that were implemented using image polls (e.g., filling out a shape with colored taps, as seen in Figure 5, or describing the location from where each participant was connected, as seen in Figure 4).

C. INSTRUMENT USED, VALIDATION, AND DATA ANALYSIS

During the course of the events, objective data on user attendance was collected through several complementary methods: Eventbrite for registered users, YouTube analytics for the number of live watchers of the video stream, Firebase and Google Analytics for a live count of devices connected, and the internal audience counter implemented by ActiveViewer.

Subjective user satisfaction was measured both during the pilot event itself (with a series of recurrent satisfaction

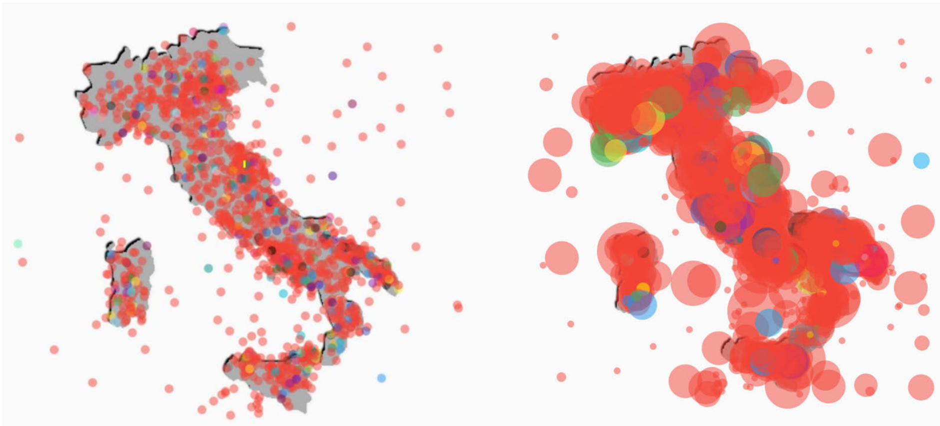

FIGURE 4. Example image polls, with answers to the question "Where are you dining tonight?" (left, unweighted poll) and "Where are you from?" (right, weighted poll where tap size depends on audience size).

FIGURE 5. Free image poll allowing participants to fill out a shape using their taps (and optionally picking a custom color).

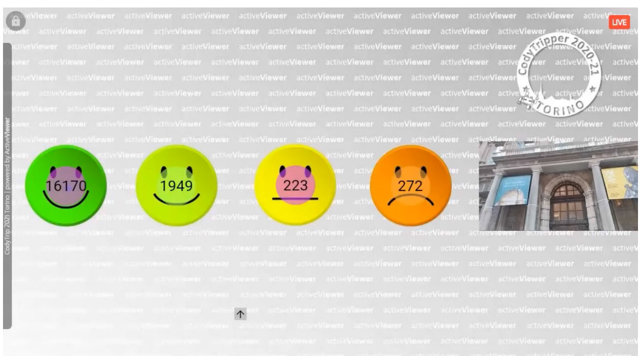

FIGURE 6. Zoned image poll, allowing participants to express their satisfaction by clicking on a color-coded face (the overlay shows the count of weighed taps).

surveys, delivered as a zoned image poll in ActiveViewer, at the end of each tour segment, as see Figure 6) and after the event, with Google Forms surveys distributed to all participants. Two questionnaires were delivered: **Survey 1** (S1), an open anonymous survey aimed at all participants (single users or users who were part of a group), and **Survey 2** (S2), for teachers exclusively, as shown in Table 1. Spontaneous feedback and comments from teachers were also collected through social channels or direct messaging chats.

Objective attendance data was used to validate the subjective feedback collected through the two questionnaires. Also, the two surveys were also used to cross-validate the collected data, as described in the following section. Data analysis was conducted on the results of the two surveys **S1** and **S2**, and the overall participation statistics collected through the various subjective data providers (analytics and ActiveViewer audience counter).

III. RESULTS

According to the Google Analytics statistics, collected through the ActiveViewer web interface, a total of 14,173 individual sessions were recorded, with a total of 62,708 page views. These stats account for page reloads, which could happen between trip segments, and for participants switching from one device to another (for instance, when connecting from school during the morning and from home during the afternoon). Participants used mobile devices like smartphones (46.9%), desktop computers including shared digital blackboards in class (42.6%), or tablets (10.5%). Windows devices accounted for approx. 48% of participants, macOS for 7%, Android 37%, and iOS 8%. 695 unique device types and 90 operating system versions were recorded. The YouTube videos streamed live were viewed 43,783 times during the event, totaling 10,480 hours of playback. The ActiveViewer visor recorded a total of 18,281 unique device connections, with an average presence of 15,904 users in the audience, who generated more than 300,000 interactions (button clicks, poll replies, etc.).

Later remote trips in 2021, performed after the first pilot event of December 2020, recorded even higher attendance numbers:

- *CodyTrip Firenze* (15 April 2021): 13,681 registered participants from over 470 cities in Italy. The trip took over 7 hours, with a peak audience of 17,000 people (from 2,100 different devices) and a total audience of 57,385 people (9431 devices).

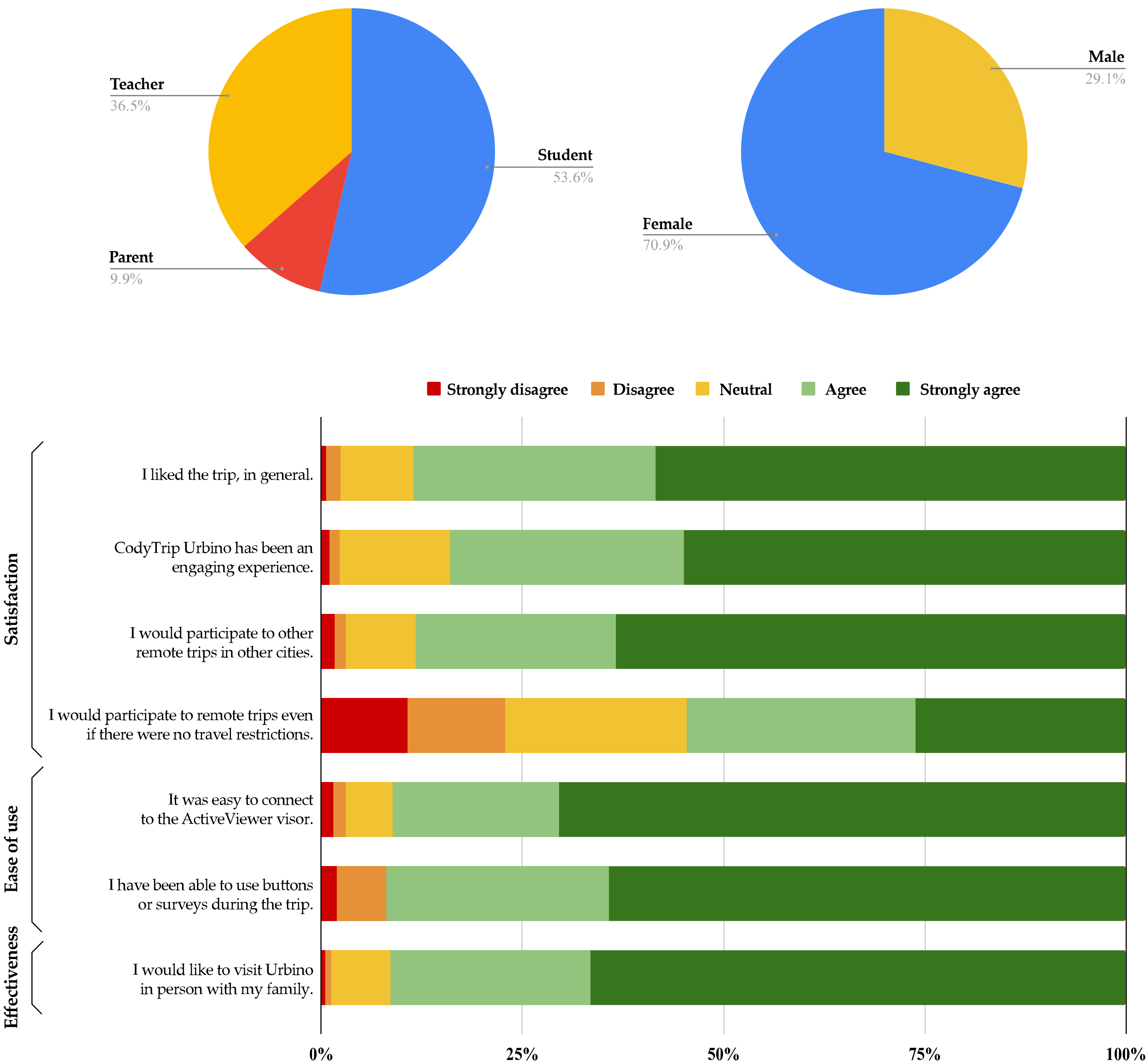

FIGURE 7. General overview of responses from S1, showing user demographics (top) and feedback on a Likert-scale (bottom).

- *CodyTrip Torino* (22–23 April 2021): 43,835 registered participants from 998 cities. The tour took almost 13 hours, spanning two days, and had a peak audience of 45,176 people (from 4,608 devices) and a total audience of 165,927 people (28,247 devices).
- *CodyTrip Salento* (13–14 May 2021): 44,901 participants registered from 933 cities. More than 13 hours and half over two days, with a peak audience of 39,716 people (from 4,056 devices) and a total audience of 173,256 people (28,636 devices).

At the beginning of June 2021, after a total of 5 events, the remote tours had registered the participation of 115,855 children from 5,274 classes in 1,881 cities in Italy. More than 250,000 parents and family members had also participated in the events [36]. According to our estimates, almost 6% of the total Italian student count, comprising primary and secondary schools, has taken part in at least one of the events listed above.

As mentioned above, two surveys were sent out in the weeks after the event: S1 was aimed at all participants (students, teachers, and parents) and obtained 1031 responses, while S2 was aimed at teachers only, collecting 236 responses overall. Figure 7 shows the overview of respondent demographics from S1, which was filled out by 53.6% students, 36.5% teachers, and 9,9% parents. More than 70% of respondents identified as female, however the

TABLE 3. Per tour segment satisfaction evaluation and participation, through an interactive survey.

Tour segment	Very positive	Positive	Negative	Very negative	Total count
Day 1, 10 AM *(Arrival)*	2196 (76%)	483 (17%)	87 (03%)	105 (04%)	2871
Day 1, 11 AM *(Library)*	1686 (73%)	348 (15%)	129 (06%)	156 (07%)	2319
Day 1, 2:30 PM *(Coding game)*	1940 (74%)	292 (11%)	155 (06%)	230 (09%)	2617
Day 1, 4:30 PM *(Ducal Palace)*	1972 (75%)	345 (13%)	114 (04%)	208 (08%)	2639
Day 1, 6:30 PM *(Christmas lights)*	2467 (87%)	193 (07%)	44 (02%)	126 (04%)	2830
Day 1, 9:30 PM *(Goodnight story)*	1725 (83%)	160 (08%)	57 (03%)	92 (04%)	2067
Day 2, 8:30 AM *(Gymnastics)*	1577 (75%)	273 (13%)	111 (05%)	140 (07%)	2101
Day 2, 9:30 AM *(Raphael's birthplace)*	1541 (74%)	332 (16%)	92 (04%)	124 (06%)	2089
Day 2, 10:30 AM *(Sightseeing)*	1253 (75%)	219 (13%)	90 (05%)	118 (07%)	1680
Day 2, 11:30 AM *(Closing)*	1536 (77%)	312 (16%)	81 (04%)	73 (04%)	2003

gender ratio breaks down more evenly at approximately 50/50% if considering only responses provided by students, while the ratio is more heavily skewed for parents (more than 80% female) and teachers (more than 90%). Subjective evaluations from all users were collected through a set of questions with replies on a standard 5-point Likert scale.

The questions, as shown in Figure 7, are divided into topics, based on whether they describe the general *satisfaction* of participants with the remote trip, the perceived *ease of use* of the technical instruments used, or the *effectiveness* of the event for its intended purpose. In this case, 'effectiveness' is intended as the event's capacity to convey interest in the visited places among participants, in order to drive cultural tourism.

IV. DISCUSSION

A. RQ1: DO REMOTE SCHOOL TRIPS PROVIDE SATISFACTORY EXPERIENCES, BOTH FOR STUDENTS AND EDUCATORS?

The anonymous participant survey (S1) was designed to provide insight on this question in particular. The responses, as shown in Figure 7, demonstrate that the participants indicated high satisfaction with the tour in general and remarked a very high engagement rate (84% of respondents expressed a positive evaluation). Also, most users found connecting to ActiveViewer easy and were able to successfully interact with buttons and surveys during the trip. Most interestingly, from an e-tourism standpoint, 91.4% of participants remarked their desire to visit Urbino in person with their families at some point in the future, thus showing that the remote visit successfully triggered the users' interest.

Also, 88.1% of users expressed their willingness to participate in future remote tours in other cities and more than half of the participants (54.6%) did remark that they would be interested in participating in other remote trips even if no pandemic-related travel restrictions were in place, against 22.7% that would not. Separating answers to the latter question by type of respondent, shows that students were less incline to participate in future remote trips (40.51% positive responses against 33.63% negative ones), while both parents (58.82% against 16.67%) and, to a greater extent, teachers (74.25% against 8.4%) were in favor of remote trips. Results align with the findings by Spicer and Stratford, according to which virtual field trips are perceived to be more effective as an educational experience, but students in particular remark that they should not entirely supplant real ones [37].

Satisfaction was also recorded during the pilot event itself, through a series of interactive surveys that asked participants to provide their evaluation on a 4-point scale at the end of each tour segment. The data collected, shown in Table 3, also supports the claim that the remote trip was satisfactory for most participants and that the experience provided a high level of engagement throughout the event, including the later segments in the evening which were mostly optional and followed independently.

B. RQ2: DO REMOTE SCHOOL TRIPS HAVE A POSITIVE IMPACT ON THE SCHOOLING EXPERIENCE, IN TERMS OF TEACHING INPUTS, PERCEPTION OF DIGITAL TECHNOLOGIES, AND SCHOOL/FAMILY RELATIONSHIP?

The teacher survey (S2) in particular provides insight on this aspect of the remote tour: Figure 8 shows the results from the 5-point Likert-scale questions about the impact of the pilot event on the experience from the point of view of teachers and their perception of the experience. More than three fourths of teachers confirmed that the remote tour provided interesting inputs for teaching activities outside of the tour itself. Also, in most cases the involvement in an interactive experience such as a remote school trip also had a positive impact on the perception of digital technologies, which have often been identified as alienating. During the evening of the first tour day, participants were invited to cook two typical recipes from the visited town. Almost 45% of participants tried out at least one of the recipes, while 9.2% tried both, demonstrating a high degree of involvement by participants and their families at home.

C. RQ3: CAN REMOTE SCHOOL TRIPS BE ADAPTED TO A WIDE RANGE OF DIFFERENT REQUIREMENTS AND PARTICIPATION CONDITIONS, DUE TO SOCIO-ECONOMIC, TECHNICAL, AND PUBLIC HEALTH CIRCUMSTANCES?

According to the teacher survey (S2), 57.2% of registered classes were attending school physically and thus participating in the pilot event from the classroom. 11% of groups had at least part of the students participating in the event from home, while 31.8% did participate remotely only, with all students connecting from home.

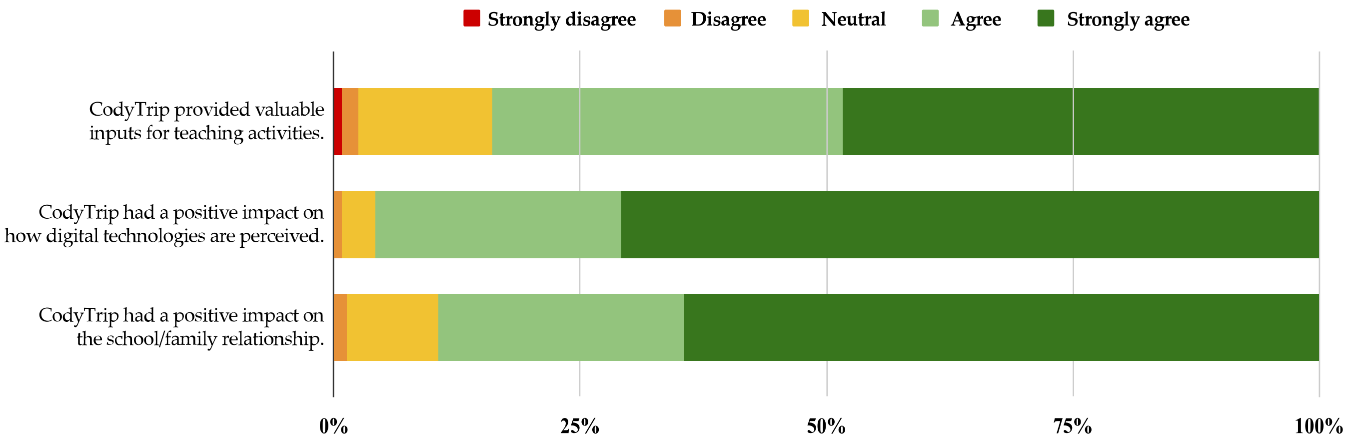

FIGURE 8. Responses from S2, showing feedback on the impact of the pilot event on schooling activities, as reported by teachers.

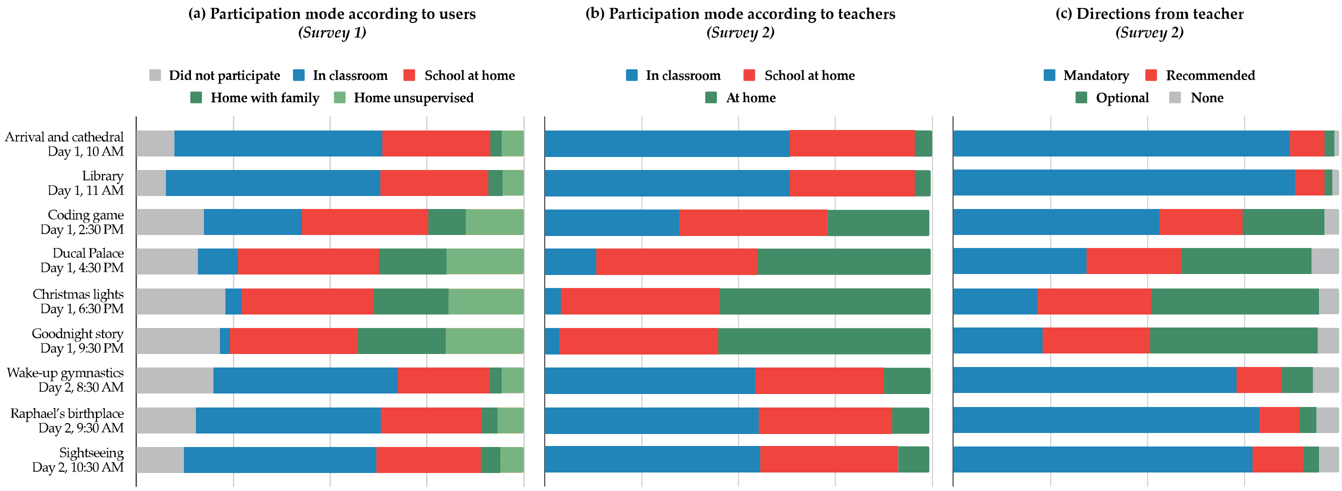

FIGURE 9. Distribution of user participation modes, per tour segment (over two days, shown on the vertical axis). (a) shows participation mode according to the respondents of the anonymous participant survey, (b) shows the participation mode adopted by the class/school, (c) shows teacher directions.

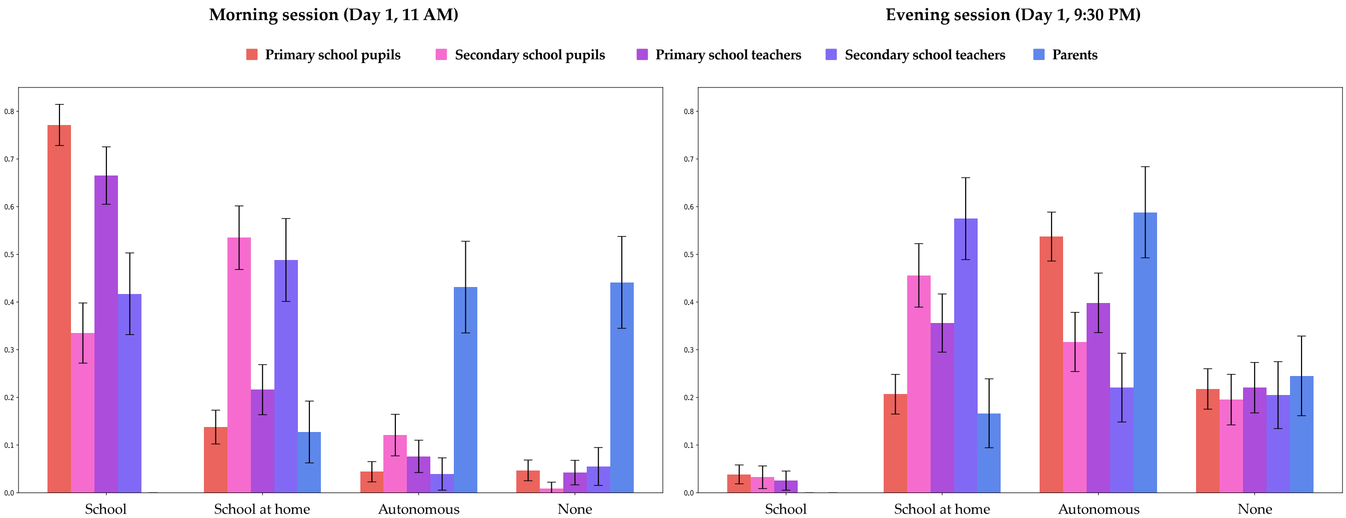

FIGURE 10. How user participation mode changes throughout the day, for two different tour segments: morning session (left), showing primarily participation by pupils and teachers from school or through 'school at home' setups, evening session (right), attended from home with a higher interest from parents as well.

How participants attended the event changed throughout the day, as most students left school in the afternoon and participated autonomously or through 'school at home' setups. Figure 9 shows the distribution of user participation per tour segment (row per row) and provides validation of the participation results collected anonymously in S1. The chart on the left (a), shows results collected in S1, where users indicated whether they participated in a specific tour segment from the classroom, from home (together with the class or individually), from home alone, or not at all. Classroom organization and directions provided by teachers in graph (b) and (c), show that mandatory activities (blue bars on the right), which concentrated during the morning of both days, were in fact followed mostly in classroom. For more than 60% of the participating students school was over by 2 PM of the first day, which is confirmed by all segments after that time of the day clearly showing a larger home audience. The correlation between S1 and S2 is 0.99 for classroom attendance (blue bars in all graphs of Figure 9), 0.89 for home with class (red bars), and 0.98 for optional individual attendance (green and light green).

Comparing differences of participation between morning and evening sessions, as seen in Figure 10, also shows that the difference in response due to age and roles is significant. Even if many tour segments were not mandatory for students (afternoon and evening sessions, in particular), many users connected spontaneously. The data confirms that the pilot event was followed by students, teacher, and parents in differing and variable setups, thus making the remote tour highly adaptable to wide range of socio-economic, technical, and public health circumstances.

V. CONCLUSION

The sudden outbreak of CoViD-19 has spawned a number of new challenges for teachers and students, which in some cases have combined with systemic issues that have made the shift to remote teaching and the adoption of flexible learning paradigms difficult. Modern tools and online platforms have the potential of providing more effective and student-tailored learning environments, which can provide support even in times of crisis.

This study contributes to the research on the adoption of remote and digital technologies for educational use, strengthening the case for a more integrated use in various aspects of scholastic life. In this paper, we have presented the case study of a fully-remote school trip, which allows traditional visits to be performed online with a massive number of participants, while still retaining key features of interactivity and immersion. Thanks to the additional features provided by the custom viewing software, remote tours are not constrained to presenting information or passively simulating a traditional visit, but they can be enhanced with forms of interactivity that empower exploration and provide engagement for participants. Our findings show that most participants have found the experience satisfactory, reporting an increase in their interest for in-presence trips to the visited location and an overall positive impact on the schooling experience according to teachers. The tour paradigm tested in the experiment has shown to be well suited to provide interactive game experiences to participants, which can provide stimulating learning experiences. There is also evidence that remote trips can be adopted for a variety of scenarios and purposes, making them useful tools in opposing the digital divide.

While remote tours presented in this paper have mainly been devised as a replacement for traditional classroom trips in the age of the pandemic, students and teachers have generally reported a large preference to repeat the experience even if no travel restrictions are enforced in the future. The intrusion of ICT in an analogue experience such as traveling and going on a school outing can be seen as alienating [25], raising concerns about health, safety, and psychological side effects due to social issues and often attributed to the abuse of digital technologies [38]. However, the remote trip presented in this paper mitigates these aspects by providing a live experience with high interactivity, which was followed by a majority of participants at school with their classes or at home with their families. In this form, the purpose of the CodyTrip experience was that of providing a *remote*, rather than *virtual*, cultural experience, that invites to perform the same trip in a more traditional and physical manner. In fact, informal feedback collected from local stakeholders confirmed that several CodyTrip participants have visited the tour destinations in the months after the remote trip.

We also wish to remark that events such as these have been perceived by many participants as a chance to interact and to share their experiences outside of their communities. Activities and trip segments, both fully interactive ones like the coding sessions and more passive ones such as museum visits, have often been exploited as teaching opportunities with additional activities organized locally by teachers for their classrooms. Both these aspects have been appreciated by teachers, who underlined the educational value of exposing their students to a wider community, an aspect of school attendance that is often sorely lacking when restrictions are in place, and the opportunity of turning an essentially passive activity such as watching a video stream into an interactive and engaging formative experience.

Remote tours can be a safe, engaging, and cost-effective alternative to traditional traveling, with the added benefit of being more sustainable and accessible [27]. It is too soon to envision the long-term effects of the CoViD-19 pandemic on tourism and traveling, but—as argued by Gössling et al.—it is to be hoped that some of the measures undertaken during this period will be seen as a stepping stone for initiatives in support of a more sustainable and resilient tourism industry [13].

A. LIMITATIONS

The proposed pilot event was based on the theme of computational thinking and did integrate game-based coding lessons. However, the case study was primarily evaluated as a shared school trip experience and in terms of its capacity to provide an engaging and entertaining experience for participants. Large-scale events, centered in particular around coding games [35], have been studied previously, but their specific impact and effectiveness as educational tools in the teaching of computational thinking should be further studied. Also, this work did not try to evaluate the remote trips based on the specific participant group size, mode of participation, presence of teachers or parents, and other parameters that may have had an impact on the experience.

There are also technical limitations that must be taken into consideration and that can hinder the actual feasibility of remote tours. While modern consumer-grade equipment (such as Bluetooth microphones and smartphones with an optically-stabilized camera) provide sufficient audio/video quality for most uses, in some cases more advanced equipment must be used (for instance wireless microphones) to ensure that the tour is effective. This can rapidly contribute to high costs on the side of the tour organizer. Also, cellular network coverage can also be an issue, in particular in more remote locations. This can be mitigated through the use of portable Wi-Fi hotspots or, for more advanced setups, with cellular bonding equipment that multiplexes Internet connections over multiple cellular carriers. In our experience, some connectivity interruptions have proven to be inevitable, in particular when transitioning from one area to another. In these cases, the ActiveViewer control room can take over the session, switching to other graphical elements or displaying an overlay, thus ensuring that the watching experience is perceived as uninterrupted as possible for the audience.

This study reinforces the case for the adoption of digital technologies for remote and virtual experiences, for an integrated school experience that goes beyond the classroom and involves students at home and families. However, further studies are required to evaluate the suitability and feasibility of similar experiences outside of the specific public health situation due to the CoViD-19 pandemic.

B. FUTURE RESEARCH

Future work will focus on the further development of remote school trips and on the organization of additional events, both on large scale and on smaller scale, leveraging the feedback collected during the pilot event. Planned new remote trips should rely more on the contribution of local teachers, allowing them to better cooperate with the tour operator, expanding the educational experience and ensuring that pupils stay more attentive.

Interactivity tools provided by the viewer software should be improved, in order to provide a more immersive experience and better communication facilities, possibly allowing single participants to engage in mini-games or full coding sessions embedded within the school trip session. Also, further research should also explore the adoption of virtual reality (VR) headsets, possibly in combination with 360-degree recording instruments, thus providing a virtual tour that allows single users and groups to navigate the visited locations with a certain amount of freedom. Future studies should also focus on how user participation modes affect the learning experience.

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