Retzzles: Engaging Users towards Retention through Touchscreen Puzzles

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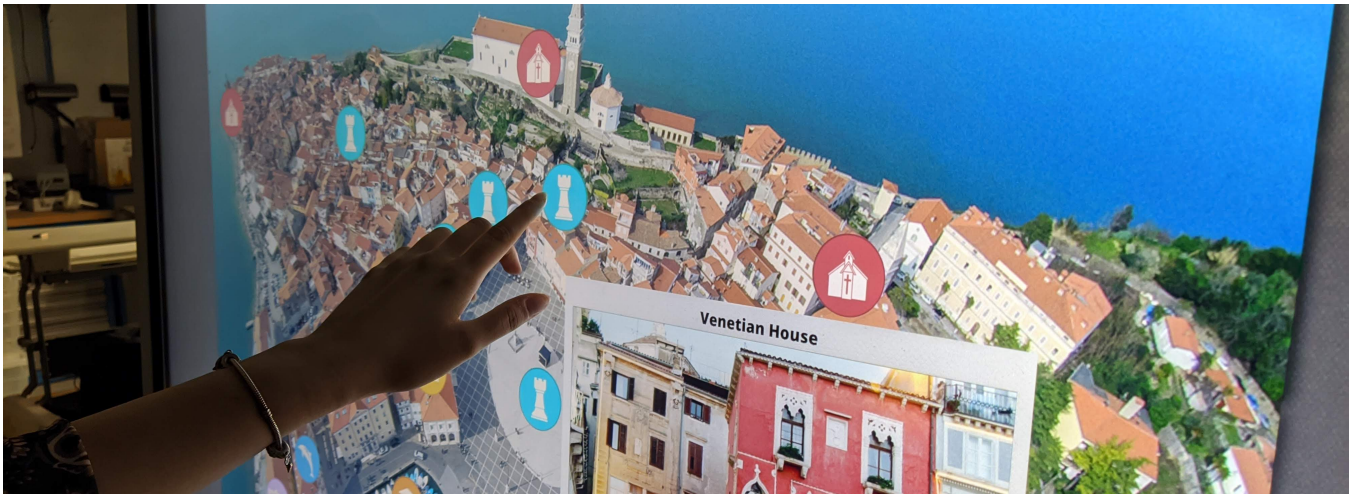

Figure 1: We present our touchscreen puzzle prototype *Retzzles*. By allowing users to focus on solving puzzles first, we facilitate engagement that aids in better information retention.

ABSTRACT

Textual sources provide limited information to their readers which could be underwhelming and may reduce engagement. Augmentation approaches have been introduced to present information more engagingly and have shown the potential in supporting information retention. In this research, we inquire further into this opportunity through the use of interactive touchscreen visual elements such as puzzle pieces. We present *Retzzles*, where users get to solve puzzles applied in a tourist use-case. To evaluate this, we will do a within-subject study with participants $n = 30$ to determine whether such elements promote engagement which thereby supports information retention. Our preliminary findings shed light on some perspectives on the use of touchscreen displays for engagement but are subject to further investigation. We contribute to more discussions on the use of interactive screens in other similar learning scenarios.

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CCS CONCEPTS

• **Human-centered computing** → **Touch screens**; • **Applied computing** → **Interactive learning environments**.

KEYWORDS

retention, touchscreen interfaces, interactive maps

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1 BACKGROUND AND RELATED WORK

Humans have been reading and writing for several millennia and these mediums have evolved and taken several forms across centuries. At present, conventional paper and flyers play a crucial role in reading – be it in studying, blogging, spreading information, and even traveling. Text-based sources (such as flyers, and brochures) have always been a very convenient way of providing readers with handy information. For instance, travel agencies make use of foldable brochures containing useful information that is helpful for tourists. Usually, the amount of information presented in these can

be overwhelming for in-the-moment thinking [21]. In general, on-hand textual sources make us stop what we are doing and require readers to concentrate on the content provided. As an effect, people may lose interest and engagement as well [13] depending on the surrounding noise and other distractions. In these scenarios, alternative information sources must be presented in an approach that works better than typical texts. Thus, when learning about what we are about to see or we are looking at that exact moment (ex. reading the flyer in front of an art piece), it is ideal that information is presented in a way that is concise, easy to navigate and gives enough contextual information [3, 6].

Museums have considered alternative means of information such as audio guides which provide tourists with the same amount of information without the same underwhelming effects brought by their paper counterparts. They have been used to conveniently deliver cultural information to visitors and can often replace on-site heritage interpreters [11]. However, audio guides have not evolved and have been replaced by more emergent forms of digital media that appear to be more user-friendly, usable, interactive, and socially-relevant. As such, various innovations in the form of digital augmentations have been introduced to address these gaps. For example, Head-Mounted Displays (HMD)'s along with mixed reality have been observed and used in education settings [16, 22–26]. They expose learners to challenging or educational situations and allow them to repeatedly practice new skills in an environment that enables correction and non-dangerous failure [7]. In general, these affordances appear ideal for teaching-related activities and the novelty of increased immersion in Virtual Reality (VR) appears to offer initial benefits [18]. However, further studies have shown that prolonged exposure may pose some substantial barriers to their uses which may not be ideal for a tourist to use. In addition, the VR setup might not be as flexible or portable as well.

Large displays and touchscreen interfaces provided alternative interfaces without the disadvantages that came with immersive headsets. In these interactive displays, we have seen information presented in different ways such as (i) gesture-based direct manipulation through the use of controllers [1] or (ii) sensors [27]; (iii) vision-based immersive effects expanding screens to 3d viewing experiences [17]; or (iv) touch-enabled interactions with visual elements projected in a screen [8]. In the latter, playful interactions have been inspired such as tangible interactive parts [20], draggable puzzle pieces and codeblocks [5, 15] and many others. In this research, we pay special attention to the use of puzzle pieces in touch screen displays as a form of digital augmentation as a potential alternative to conventional text-based information sources applied in engagement and information retention.

Puzzles, by definition, are fun and have been observed to help make learning enjoyable for students [9, 12]. Existing frameworks and research support that activities where people "learn by doing" along with social interaction supports cognitive development which then helps users learn in general [14]. Specifically, the use of jigsaw elements which is one of the most common puzzle games has been observed to help students acquire a deeper understanding of certain concepts and terminologies [10] in the broader context of learning. In summary, this research presents preliminary findings and provokes insightful discussion on the following targeted contributions:

- **Artifact**: We present the prototype *Retzzles*, an interactive touchscreen interface that allows users to solve puzzles towards supporting information retention.
- **Empirical**: The results of a user study that compares the effects of using traditional information sources vs our prototype applied in a tourist use-case scenario.
- **Design**: A set of recommendations learned from our user studies in helping interaction designers in the development of surfaces and screens that help in a specific learning scenario.

2 RETZZLES: DESIGN AND IMPLEMENTATION

We designed our interaction following some benchmarks in the literature on the context of learning and tourist information systems. In this section, we talk about the design and concept behind our prototype entitled *Retzzles*. We drew some inspiration from the theory of constructivism, where people actively construct or make their knowledge, and that it is on the user to create their reality [4]. While the end goal of the puzzle for everyone will be the same, the path toward achieving a solution will be unique for each user. As the puzzle is being built, the user is piecing together the knowledge as long as they play the game. With *Retzzles*, users are building the puzzle which represents a map of a tourist destination so the final map is the same for everyone, but the story is personal. On this map, we put information points about the important monuments of the city. We are trying to pique the curiosity of the users with this, to make them interact and learn.

In *Retzzles*, users can move the puzzle pieces and put them in the correct spot. In the puzzle, there are points of interest (POI) that contains specific information about a specific touristic spot. Users may uncover the map/picture of a specific POI that they want to read more about. As the user solves the puzzle, POIs become revealed when the right puzzles are pieced together. These buttons are clickable and they provide the user with the information about the touristic monument they are placed at on the map.

We used Unity to build this prototype. Jigsaw puzzles were created using GIMP and its pattern feature "jigsaw". In this specific map, we identified 6 different types of buttons representing categories of tourism namely, church, structure, palace, aquarium, and theatre. We found a bird's eye view picture of the city of Piran, to make an augmented map with the said assets. We augmented this photo by adding buttons on the location of the monument, where the icon of a specific POI represents the type of the monument. The puzzles are all organized into one empty parent game object. Each piece is assigned with the `DragObject` script, which allows them to be moved and dragged anywhere on the screen. This script contains the logic of how the puzzle pieces snap into the correct position. Because our pieces are treated as sprites in Unity, we used polygon collider 2D to handle the physical collisions. The collider's shape is defined by a `freeform` edge made of line segments, which is easily adjustable to cover any shape, in our case any jigsaw puzzle.

Within the prototype, we have added some automated mechanisms to log data for better analysis. We are tracking the amounts of moves/clicks for each puzzle piece, activating information points / POIs, as well as the time needed to solve the puzzle and open and read the information points and many others.

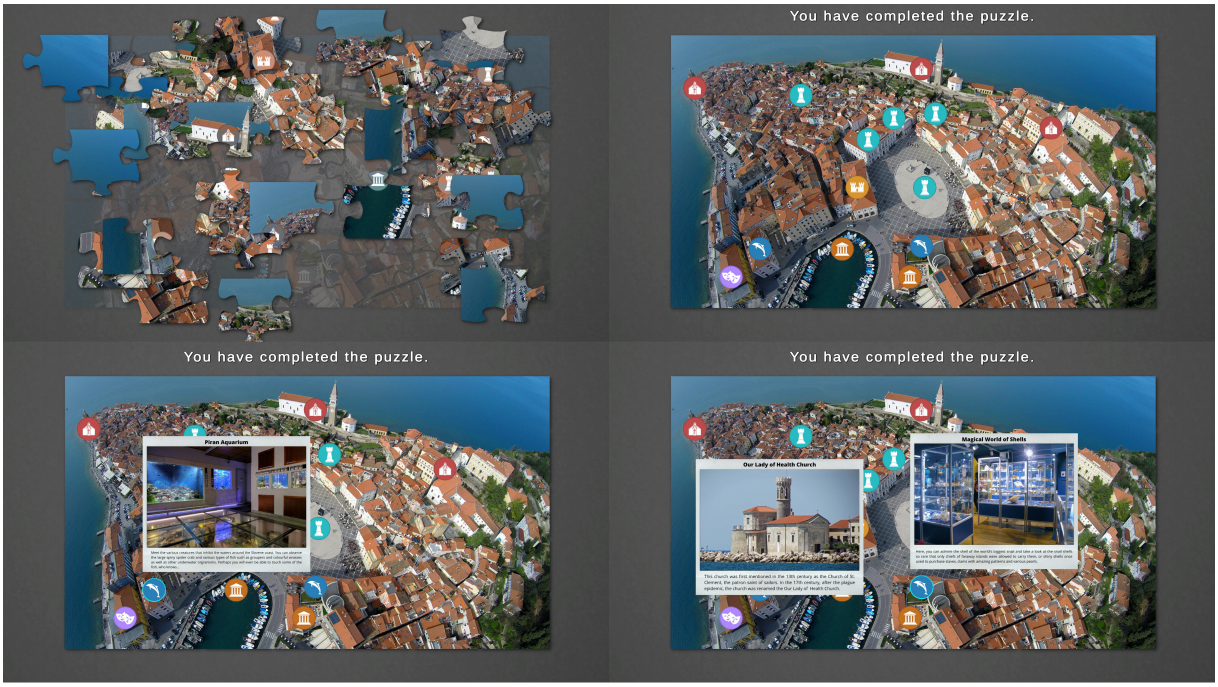

Figure 2: Different Views of Retzzles. Top Left: The puzzle begins unsolved. Top right: The view of the solved puzzle. Information points become "merged" and are clickable for users to view additional information. Bottom: Different views of information points revealed (single point - bottom left, multiple points - bottom right).

3 METHOD

In order to validate our hypothesis, we will conduct a within-subject study design with at least $n = 30$ participants using convenience sampling. It is preferred that our participants are not familiar with or have not learned any information about the touristic place that they will be exploring. Our users will be subjected to two conditions namely (1) using the paper flyer as a source of information and (2) using our prototype *Retzzles*. They will be given a chance to learn more about a specific touristic place using both variables. After using both mediums, they will be subjected to an assessment task that will evaluate how much information was retained and which medium contributed to this.

3.1 Task Protocol

We will provide our participants with information regarding a specific touristic destination. In this scenario, we will use tourist information on the municipality of Piran, a famous city on the Istrian coast in Slovenia. On both conditions, they will be provided with a medium that contains information about the given place namely (1) a paper flyer and (2) using *Retzzles* on a touchscreen interactive stand-up display.

To investigate the interaction performance with the touchscreen display, we have prepared an illustrative scenario that covers all the interactive features of *Retzzels*. It consists of solving the puzzle and opening information points while the puzzle is being solved or when the puzzle is finished (see Figure 2). The user 1) begins with puzzle pieces scattered on the screen (usually programmed to be in random places), 2a) moves the pieces anywhere on the surface (for example: from the center to get a better view of the background image which is there to help and guide the users to complete the puzzle) or 2b) starts putting the pieces in their desired spot based on the shape and the content of the puzzle piece, after the path has been chosen, 3) clicks on the buttons that represent important monuments of the touristic destination, 4) learns about the specific touristic destination and its distance from the other monuments.

3.2 Evaluation

We will assess users on two criteria: (1) contextual information and (2) spatial understanding. In addition to that, we will also be measuring the overall experience using the SUS questionnaire [2] and User Experience Questionnaire (UEQ) [19]. In focus, the users will be presented with questions regarding the spatial understanding of the touristic monuments they pieced together. Such questions would include (a) "*Do you recall a place called Tartini Trg? and if so...*", (b) "*How many meters is it away from the city center?*". These questions will hopefully give us an understanding of how the users retained the contextual and spatial information presented to them. We will analyze and assess the mean average scores of the participants and see if there is a significant difference in the effects of using both conditions.

4 PRELIMINARY RESULTS

As of writing, we have implemented yet a full comprehensive user study for this research. However, we were able to conduct an alpha

version of testing to validate whether our initial design and our interaction achieves an acceptable level of usability. In doing this alpha test, we invited $n = 3$ participants and let them use the initial version of the prototype. We did not give any other instruction other than to use the screen, complete the puzzle and think out aloud while using the prototype. They were only given 15 minutes only to use the prototype freely.

We observed all 3 participants to have used one hand to interact with the jigsaw pieces. Only 1 out of 3 tried to use multiple touches (by using different fingers) to move certain puzzle pieces. To their discovery, this feature was not supported. In terms of interaction, all 3 participants were constantly looking at the shape and the content of puzzle pieces while they were solving, pieces that had parts of the info point buttons were much more distinguishable than the others (barring the corner pieces). 2 out of 3 participants disliked that there could be multiple information points open at once, where the other participant argued how it made the experience more immersive. Users said that they much preferred having the background image as it helped them constantly recall the objective of what they've been working towards. According to them, this does not remove the challenge of solving the jigsaw puzzle throughout.

5 CONCLUSION AND FUTURE WORK

In this paper, we wanted to investigate whether a typical interaction with a standard touchscreen display can be used to support knowledge retention by enhancing engagement. Specifically, in our approach, we designed the interaction consisting of jigsaw puzzles and "unlockable" information points that were available for the users to read and navigate with. In this context, we explore this in a tourist scenario where users are tested whether their established engagement thereby helps information retention as well. In this study, we presented the initial version of our prototype *Retzzles* containing these features along with the findings of an alpha user testing. Whether the effects of our proposed interaction will be effective or not will have yet to be validated in a more formal user study described in our method section. We are also considering integrating a mixed reality approach to discover whether there are differences in terms of interaction or direct manipulation with the puzzle pieces concerning engagement and retention. We hope to uncover findings that will guide future designers in the design and development of engaging interactions for practical cases such as tourism, civics, and other related fields in digital humanities.

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