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Fostering access to cultural heritage knowledge: iterative design for the visit of historical monuments

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Abstract. Following the trend towards open data, various cultural organisations offer information about their collections. However, these knowledge bases are not used to accompany a visit to historical monuments. We think that a possible explanation for this observation lies in the distinction between availability and accessibility of the knowledge offered: although these knowledge bases make this knowledge available, it is difficult for non-experts to make use of it and make it their own. Rather than a semantic approach to visiting based on description, we advocate an active and semiotic approach based on comparison. We have identified four challenges in applying this approach to church stained-glass windows. The first two challenges are to link the physical space of the building and the stained glass with the documentary space so that visitors can move between the two. Visitors also need to understand and use 'reading keys' to match a representation with its subject. Visitors should afterward finally be able to use their knowledge and skills on other visits. Through interviews and observations, we have iteratively designed paper and digital prototypes to meet these challenges.

Keywords: cultural heritage, user study, knowledge organisation system, user experience

1 Introduction

Traces of the evolution of societies can be found in cultural heritage, including art, industry, architecture, traditions, stories, etc. [1]. By studying these traces, we can understand the past in order to better anticipate the future. However, if not made available to the public as a common good, the knowledge gained from these studies may be lost [2]. Nowadays, through the Web, many platforms, both private and public, make this knowledge available. The modelling of the available knowledge can take two opposed forms. The first approach is based on a high degree of genericity (sometimes at the cost of a certain impoverishment) and allows the constitution of global databases. The second, based on a high degree of malleability of the infrastructure, allows a "specific"

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approach adapted to local contexts. In both cases, these knowledge bases aim to provide a better understanding of cultural heritage.

The objective of providing a better understanding of the cultural heritage is shared by the cultural heritage visit tools. It is therefore logical to find more or less the same two approaches described in the previous paragraph: the reuse of global databases¹ or, on the contrary, the site-specific visit². As most stained-glass windows are located outside museums, they are one of the most striking examples of this dual approach. A visiting tool must have a generic approach to cover all the places where they can be seen³. But there is also a need for local “specifying” to understand each individual stained-glass window [3]. In this article we propose an “in-between” approach (between genericity and specificity) using an “expert knowledge bank”. The approach has been applied in the city of Troyes, a historical city in the east of France. The aim of this approach is to facilitate access to knowledge in a generic way when visiting several sites, while maintaining the “specificity” that one could have by using a support designed for a specific site.

This article is divided into three sections. The next section shows how knowledge bases can be used to create new knowledge and skills from cultural heritage. We will then see how this approach can be applied to the visit of stained-glass windows in Troyes. Section three discusses the design rationale of a hybrid visit tool for this area. In the final section, we will discuss the feedback received from the visitors and thus the resulting design choices that seem most relevant to keep for future work. We will also discuss the current limitations of this hybrid design.

2 Accessing cultural heritage through knowledge bases

2.1 Cultural heritage knowledge bases

Following the trend towards open data, various organisations are making cultural heritage knowledge available on the web [4]. Public institutions are opening up national inventories⁴. These digitised collections are mainly used by professionals, experts or hobbyists to find information, confirm hypotheses or illustrate articles [5]. Major museums also offer scans and information about their collections⁵. This opening not only makes the unexhibited parts of their collections visible, but also attracts new visitors who will be able to prepare their visit [6]. Private actors are collecting, arranging and

¹ For instance, *Pokemon Go* (2016) and *Harry Potter Wizards Unite* (2019) from Niantic.

² For instance, phone games from Troyes Champagne Tourisme (<https://jeux-de-piste.troyeslachampagne.com>) and applications from Explor Games (<https://www.explorgames.com>)

³ 9000 square metres of stained-glass windows spread over 6,004 km² in 211 communes in the Aube department.

⁴ For instance, *Europeana* (<https://www.europeana.eu>) from the European Commission and *POP* (<https://www.pop.culture.gouv.fr>) from the French Ministry of Culture.

⁵ For instance, *Collections* (<https://collections.louvre.fr>) from the Musée du Louvre and *Rijksstudio* (<https://www.rijksmuseum.nl/en/rijksstudio>) from the Rijksmuseum.

offering virtual exhibitions to present cultural heritage knowledge to the general public⁶.

These knowledge bases are mostly used *ex situ* (i.e., at a distance from the consulted works). However, these knowledge bases can also be relevant during a visit *in situ*, in front of the consulted pieces. For example, describing a work of art by the painting technique used is relevant both *ex-situ* and *in situ*. However, as far as we know, there are no knowledge bases accompanying a visit *in situ*, nor users hijacking existing ones. One possible explanation lies in the distinction between availability and accessibility of the knowledge offered: although these knowledge bases make this knowledge available, it is difficult for non-experts to make use of it and make it their own [7]. In fact, the accessibility of knowledge can be questioned in the context of autonomous use by the general public.

2.2 From knowledge to knowing

Accessibility to knowledge inside these knowledge bases is not only a problem of openness or even ergonomics. There is also the problem of how users of these knowledge bases "interrogate the work to reveal its semantic richness and make it understandable" [7]. This problem questions the very place of knowledge in the process of understanding. As John Dewey wrote, knowledge is only the product of inquiry after a problem has been solved [8]. In the case of cultural heritage, as in a reading situation, the meaning does not come from the text, but from the reflective attitude of the visitor [9]. Her knowledge can evolve to include new information based on her observations.

It would be wrong, however, to ignore the role that the organisation of displayed information plays in the construction of meaning. As Verón and his colleagues wrote, "exhibiting is not simply giving access to a meaning that would, in all autonomy, be proper to what is exhibited; exhibiting is always and inevitably proposing, from what is shown, a particular meaning" [10]. But if, as we saw earlier, meaning is constructed by the visitor, and is specific to him, the designer can only hope to assist, or at best guide, the construction of that meaning. In order to answer this challenge of individuality, Ioannis Kanellos proposes to adapt the information offered to each visitor by means of "navigation modes" and "points of view" [7]. Each "point of view" represents a different aspect of the work (e.g., technical, contextual, aesthetic, interpretation, etc.), while each "navigation mode" is a different sequence between these aspects (e.g., discovery, study, deepening, etc.). These "points of view" and "navigation modes" allow the user to compare works of art to identify their common semantic features [11]. These successive comparisons force the user-visitor to question the current state of her knowledge by adding new singular elements.

2.3 Knowing by interacting with information

These successive comparisons are made on the basis of information relevant to the user-visitor's questions. She extracts new knowledge from this information and from her

⁶ For example, *Arts & Culture* (<https://artsandculture.google.com>) from Google.

experience [12]. This reflective stance is part of a long line of so-called "learning by doing" approaches. Popularised by authors such as Dewey and Peirce, these approaches encourage the active participation of learners. Experiential learning is one of its applications. Based on the reflective observation of a concrete experience, the learner will propose a conceptual abstraction that she will implement in an active experiment [13].

Games are a good example of creating new knowledge through experience. In order to understand the systems that govern the game environment, the player must test her assumptions about how these systems work in each unfamiliar situation and then compare the results [14, 15]. Through these cycles of "successive challenges", the player understands more and more about the systems that govern the game and the way to achieve her goals [8, 15]. By proposing role-playing situations, game designers can make it easier to see the consequences of these actions on oneself, others and the environment, thus allowing reflective observation [16, 17] and can put the player in the position of an expert (e.g., taking part in a collaborative inventory and interacting with peers [18]). However, if the playful part takes precedence over or is too different from the reflective part, the game will not be able to accompany the reflective stance [19, 20].

2.4 Knowing outside museums

As the backbone of the mission to disseminate cultural goods to as many people as possible, museums are a privileged place for transmission and learning [21]. In a museum context, external factors that affect an impact on learning (such as temperature, lighting or geographical extent) are relatively controlled [22, 23]. In addition, the place is designed to contain written materials to help visitors orient themselves and understand the works [24].

Outside museums, however, there are constraints inherent in the places visited that limit control over these external factors. We can categorise these constraints into four different types: geographical, functional, legal or physical. The first is found in large places, such as cities, or where elements of particular interest are scattered over an area. Functional constraints are found in places that are also used for other than cultural purposes, such as institutional buildings that receive visitors. Legal constraints limit what can be done, for example in a protected natural area. Physical constraints are inherent to this type of visit. Unlike in a museum, where scenography plays a special role, it is difficult or impossible to control it outside museums.

3 Iterative design for visiting historical monuments

In the previous section we saw how it is possible to use the information contained in knowledge bases during a visit. In this section we will see how we have iteratively designed paper or digital prototypes to implement this idea of accompanying a visit to a stained-glass historical monument.

The majority of stained-glass windows are found in religious buildings. These buildings combine all four of the above constraints. The geographical constraint, due to their

dispersion and the quantity of artworks involved³. The functional constraint stems from their dual purpose, both religious and cultural [3, 25]. The majority of these buildings are classified as historical monuments, which legally restricts any modification [26]. Last but not least, visiting buildings limits the control and possible changes of the environment (such as visibility, luminosity, temperature, order of stained-glass windows).

3.1 Methodology: between theorising, designing and observing

Research on human interaction with tools needs to take into account that the user adapts to the tool and at the same time adapts the tool to her practices. This type of study therefore requires a regular exchange between theoretical models, artefact designs and observations [27]. Inspired by the practice of redesigning museum panels, we undertook design cycles to identify elements of friction with visitors [24]. These were addressed through iterative adaptation of our documents. These cycles consist of on-site permanencies interspersed with minor adaptations (superficial changes such as spelling mistakes, minor omissions, sentence or vocabulary clarifications) and redesign (major changes to content, presentation, activity order).

We structured our experiment through five design cycles. The first four cycles took place in the church of Saint-Jean-au-Marché in Troyes. During these cycles, we offered church visitors to use our documents during their visit⁷. The visit was followed by a short interview to collect their feelings and remarks. In the last cycle, to limit the influence of personal motivation to visit the church, we tested our documents in the context of a course dedicated to the discovery of stained glass⁸. During three hours, the students visited three buildings similar to the church of Saint-Jean-au-Marché. During these visits we shadowed the groups and also conducted short interviews after the visits.

In this first experiment, our aim was to explore how we could design an active approach to the visit. Based on learning-by-doing approaches and some game design elements, we designed our supports to understand how visitors could create new knowledge through experience. Later, we replaced some of our paper prototypes with digital ones, laying the groundwork for content reuse between sites. We chose a qualitative approach in order to go beyond trends, to cope with each visitor's point of view, even rare ones [28]. Singular experiences help us to identify unforeseen design challenges and address them iteratively in the next cycle. In the first cycles, our aim was to design, test and improve our paper prototypes. Between cycles, we labelled interview transcripts. We associated situations, difficulties and design choices until saturation [29]. This approach allows us to describe a situation in detail and better understand difficulties (e.g., if a visitor cannot identify a figure, it is either because they do not understand the artwork, they cannot identify certain parts of it, or they do not understand the story of the figure). In the last cycle we extended our approach to several buildings in order to observe the challenges of multiple visits.

⁷ Our documents were used by 19 visitor groups (from 1 to 4 people). In the verbatims below, each group is identified in chronological order.

⁸ The students divided themselves into 8 groups (from 3 or 4 people). In the verbatims below, each student is identified by a unique number.

3.2 Design challenges to enhance historical monument visits

The information used for the design of our prototypes comes from an inventory created by the CNRS⁹, the *Corpus Vitrearum* [29]. This inventory contains technical information (size, materials, etc.) and iconographic information (story, character, etc.). This information describes the stained-glass window, but it does not explain it. In order to make these stained-glass windows accessible, we had to overcome four design challenges. Firstly, to enable visitors to match the information in the documents with the corresponding part of the stained-glass windows, and secondly, to enable visitors to associate the information in the documents with the corresponding part. Once they have found the right part of the stained-glass window, visitors need to understand and use 'reading keys' to match an image to the right subject. Visitors should then be able to use their knowledge and skills on other visits. To meet these challenges, we decided to design three different types of documents: an index, thematic itineraries and a notebook. This choice allows us to offer different types of visits and to introduce visitors to the use of an inventory. The index presents each stained-glass window and allows free consultation. The itineraries guide the visitor through a specific topic. The notebook accompanies the visitor so that she can take notes.

Linking the physical space with the documentary space. As mentioned earlier, there were a number of constraints that made it difficult to make physical changes to the building (e.g., with a descriptive plaque). However, when using tools, visitors need to know which stained glass is explained by the information they read or hear.

In order to create a clear link between the physical space and the documentary space, we have chosen to retain the “system established by the *Corpus Vitrearum*. All the stained-glass windows on the south side of the building have an even number, while those on the north side have an odd number. The hundred represents the floor (0 to 99 for the ground floor, 100 to 199 for the first floor, etc.). This standardised identification is used throughout Europe. First, to understand which approach would facilitate the use of standardised identification, we compared two presentations: by stained-glass windows (see Fig. 1.A) or by topic (see Fig. 1.B). Later we added a front cover to the index to explain the standardized identification of stained-glass windows (see Fig. 1.C). To encourage visitors to use this identification, we added exploration steps to the itineraries. These steps require the visitor to move towards a particular stained-glass window. A large map was also added to the notebook and index cover to assist these exploration steps. In previous cycles we observed that the organisation and size of the index did not seem appropriate for a visit:

“It's very good to use, but it's not practical to have them in numerical order. I always have to think and make sure I'm on the right page. I'd have to put them in order of visit.” (Visitor #11)

To overcome these problems and make it easier to add new buildings, in the fifth cycle we modified the interface of an existing digital knowledge base [30, 31]. We

⁹ Centre National de la Recherche Scientifique (National Center for Scientific Research)

added a map with the standardized identification scheme and photograph of each stained-glass window (see Fig. 1.D).

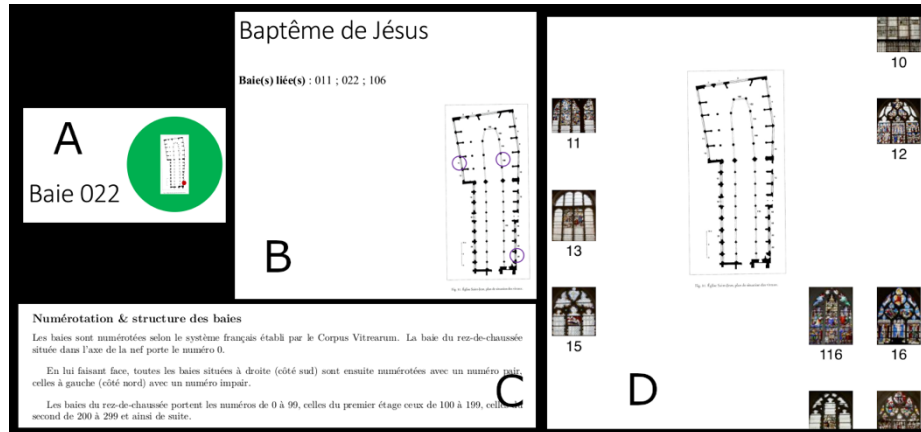


Fig. 1. Linking between the physical and the documentary space (A. stained glass window approach; B. thematic approach; C. explanation of the standardized identification; D. map with thumbnail and number). (Documents excerpts and software screenshot)

Associating information to the corresponding part of the stained-glass windows.

Although often described as "comic strips" from ancient times, stained-glass windows are complex works of art to understand. In addition to iconographic knowledge, many stained-glass windows use specific narrative techniques. In order to explain a stained-glass window, our tool must be able to refer to a specific part of it.

To identify the part of a stained-glass window, we have chosen to use the architectural vocabulary of a window. This vocabulary can be applied to any window and is easier to use than the standardised identification established by the Corpus Vitrearum. We added a location attribute to each source in the stained-glass window (see Fig. 2.A). To identify this location, we used architectural vocabulary and placed a diagram on the cover page to explain it (see Fig. 2.C). In itineraries, we have also included photographs with captions to illustrate some of the topics (see Fig. 2.D). We also added some of the practical activities related to finding an element in a stained-glass window (finding the order of a story, finding a character in the building, etc.) (see Fig. 2.B). In the fifth cycle, the digital prototype contains both entries describing the whole stained glass window and entries describing its details. To find the appropriate page, the user-visitor has to compare the actual stained-glass window with a photograph (see Fig. 2.E).

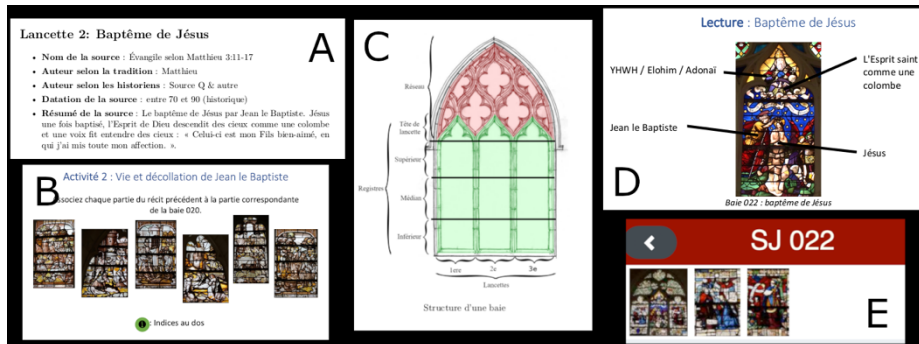


Fig. 2. Associating information to the corresponding glass panes (A. description of a topic with location in title; B. example of activity; C. diagram of architectural vocabulary; D. example of captioned photographs; E. example of fragments of the same stained-glass window). (Documents excerpts and software screenshot)

Matching subjects and representations. While some stained-glass windows are easy to understand (e.g., the Crucifixion or the Last Supper), others may be difficult to understand. With large knowledge bases, similar subjects can easily be confused without clear "reading keys". Our tool needs to be able to associate the right subjects with the right representations.

To enable visitors to identify the 'reading keys' and associate subjects and representations, we have chosen to introduce visitors to historical sciences skills. With these skills they should be able to identify the representations on their own. We have chosen to associate each topic with a source (e.g., excerpts from ancient texts, encyclopaedia articles). These sources are described by title, author, date and a brief summary (see Fig. 3.A). Each source also has a QR code that provides access to the full text. For the ancient texts, in order to be closer to historical sciences, we have chosen to direct visitors to a translation comparison tool rather than to select one of the texts (see Fig. 3.B). With this philological approach, visitors can do their own comparison of different versions of the same source, as a historian would. In addition, in order to move a little closer to the practice of historical scholarship, we have systematically indicated the author of the source, according to tradition and according to historians (see Fig. 3.A). We have also added a heading to each stained-glass window, indicating the date, the author and the techniques used (see Fig. 3.C). These changes were made in response to visitors who were more interested in the technical aspect than the religious one:

"It is also important to have the date of the work" (Visitor #7).

Moving on to the fifth cycle and the numerical index, each stained-glass window is described by tags divided into two points of view ('history of religion' and 'history of art') (see Fig. 3.D).



Fig. 3. Matching subjects and representations. (A. description of a topic; B. example of a comparison between two ancient texts; C. example of a heading; D. description of a stained-glass window in the digital index). (Documents excerpts and software screenshot)

Remobilisation of knowledge and skills. As shown in a previous article, most stained-glass windows mediation tools in Troyes represent singular, non-reusable knowledge [32]. Unfortunately, given the geographical constraints outlined above, it is not possible to cover every stained-glass window. In order to include the uncovered windows, the knowledge must be reusable. Reusable knowledge also empowered visitors by giving them 'reading keys' to use on each subsequent visit.

In order to make knowledge reusable, we have chosen to use a thematic approach (the topics are applicable to several stained-glass windows) rather than a singular description (applicable to a single stained-glass window). In addition, the standardised identification and architectural vocabulary presented earlier, can be reused in other buildings and in other existing mediation tools¹⁰. We organised the itineraries into reading steps (see Fig. 4.B) and practising steps (see Fig. 4.C).

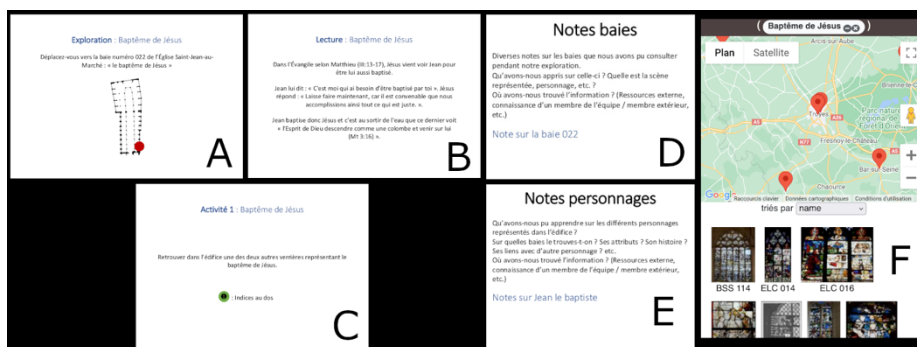


Fig. 4. Remobilisation of knowledge and skills (A-B-C example of sequence "Exploring (A) -> Reading (B) -> Practising (C)"; D. notes by stained-glass windows; E. notes by character; F. thematic research). (Documents excerpts and software screenshot)

¹⁰ For instance "Minois, D., 2012. Les vitraux de Troyes : XIIe-XVIIe siècle." and "Rivale, L., Dohrmann, N., Lloza, B., 2016. Les Triomphes de Pétrarque."

We then restructured them into a series of "Exploring -> Reading -> Practising" sequences (see Fig. 4.A-C). Reading steps presents information related to the topic (the story of a saint, the representation of a story, etc.). Practising steps allows visitors to develop their skills by using the information they have already seen (identifying a story, finding a character in the building, etc.). To encourage visitors to identify the important aspects of a topic, they can take notes (see Fig. 4.D-E). In the index, stained-glass windows with similar topics have been added to the header of each page to facilitate comparison. In the fifth cycle, the use of a digital index allows all the stained-glass windows in a topic to be displayed simultaneously, also facilitating comparisons (see Fig. 4.F).

4 Discussion

In this section, we discuss the results obtained for the four design challenges presented above. We will compare them with other approaches. In the final section, we discuss the limitations of our current study.

4.1 Open problems to enhance historical monument visits

Linking the physical space with the documentary space. As one visitor asked, "*Why not add a little text to each stained glass?*" (Visitor #8). In addition to the constraints on physical changes to the building, other respondents did not want to see a place of worship turned into a museum with the use of explanatory panels:

"[...] panels are too much like a museum. Not because I don't want to read, but out of respect for believers who don't necessarily want to be in a museum." (Visitor #17)

"A lot of people ask me why there aren't any explanatory panels, but this isn't a museum. I've already suggested the idea to the priest, but he didn't like it. The faithful should already know how to read what's on the glass." (Keeper)

However, we believe that this approach seems to go against the very idea of a visit, which is supposed to help visitors build new knowledge. For example, using a map and standardised numbering enables visitors to develop skills that can be reused in other contexts (subsequent visits, use of an inventory, discussion with an expert, etc.). With the installation of individual panels, visitors would not develop these skills:

"It's really interesting because you learn more, you manage to read the stained glass, whereas normally you just look at the drawings, but you don't know exactly what they mean. After a while you start to see the donors, the saints, the stories." (Student #17, 2nd visit)

Associating information to the corresponding part of the stained-glass windows. Another possible approach could be the automatic recognition of stained-glass windows. For example, this approach was chosen for an application for the stained-glass windows of Sainte-Chapelle. Judging by the comments on the application shops, it

seems to be appreciated and awaited (28 comments out of 38^{11,12}). It makes it much easier to find information by associating it with the right work. However, this approach also seems to go against the construction of new knowledge. In fact, such an application delivers the information and leaves the user as a spectator of the cultural work. They are never helped to develop new skills. Some users of the Sainte-Chapelle stained-glass windows application explicitly criticise this fact:

“The free version provides only the names of the stained-glass windows. No explanation of the stained-glass windows, which does not empower the curious visitor.” (Google store user, April 2018)¹¹

“Where is the explanation of the scenes shown? The techniques used? The history of this great place? I expected more from a national monument.” (Apple store user, October 2017)¹²

Matching subjects and representations. To help the visitor-user understand the key elements of a subject, we have proposed semiotic approaches based on comparison (of ancient texts and stained-glass windows) and semantic approaches based on description (of a stained-glass window and a subject). On one hand, a comparative approach comes closer to art historian’s practise. On the other hand, the comparison with ancient texts has been little used (4 accesses by 2 groups out of 17 with the index). The use of QR codes and the number of documents seem to be the main factors. In view of this observation, it seems to us that the problem does not lie in the comparative approach, but in its form. During the thematic itineraries, visitors are also encouraged to compare representations of the same subject in order to identify the “reading keys” to understanding it. To identify these keys, visitors have to compare their initial knowledge with each new stained-glass window they consult. Visitors seem to have appreciated this approach, which involves “successive comparisons” of their knowledge:

“We really discovered the attributes of the patron saints as we went along. So now when you see a patron, you know that you’re going to look behind them and you know that you recognise this or that attribute and so you’re able to recognise them. And I think it’s much more enjoyable because you immediately understand the scene you’re looking at.” (Student #13, 3rd visit)

Remobilisation of knowledge and skills. During the design phase, we noticed the benefits of a visit structured into sequences of “Exploring -> Reading -> Practicing”. Based on that, we believe it is possible to automate the creation of itineraries using bricks with different levels of difficulty. Reusing the same brick in different itineraries and buildings could make it easier for visitors to reuse previously acquired knowledge. However, interested visitors have indicated that they get bored with repeating the same topic:

“It was good because we revisited things we learned [...] in the previous church, but it’s the same saints and we could have learned more about new saints” (Student #6, 3rd visit)

¹¹ <https://play.google.com/store/apps/details?id=com.cmn.vitrauxsaintechapelle>

¹² <https://apps.apple.com/fr/app/vitraux-sainte-chapelle/id1117906282?see-all=reviews>

We also noticed that note-taking during the visit did not seem to correspond to a visit of a historical monument. Only 6 out of 9 notebooks were used for note-taking and the other 10 groups refused the notebook. The main reasons seem to be the temperature, the amount of space and the lack of interest in this activity. In order to allow the visitor-user to keep a record and build up their own collection of stained-glass windows, the addition of “favourites” could be considered. However, this feature is a far cry from note-taking, where visitors need to formulate their knowledge. The ability to share on social networks could encourage this formulation.

4.2 Limits of our study

As we have seen in the previous section, there was a short-term re-mobilisation of skills when the activities were carried out. However, further research would be needed on the medium- and long-term retention of knowledge. Furthermore, during the last cycle we tested our documents in the context of a course on stained glass discovery. Although it is a “natural” setting since students volunteered for this course, once the visit started, they had no option to stop if they found it uninteresting. In addition, our experiments were conducted in a very specific visiting context (stained-glass windows in a French historic monument) and can therefore only provide potential clues for other contexts.

5 Conclusion and future works

In this article we have discussed the challenges in the design of visitor tools for historical monuments, especially churches. Although many open knowledge bases exist, the accessibility of knowledge can be questioned. It is not just a question of openness or even ergonomics. It's about the very way in which users are able to develop their knowledge and skills from the information that is available in these databases. We advocate an active approach to visiting. Where visitors gain understanding by using information to create and remobilise knowledge and skills. To bring visitors closer to the practices of an expert, we have iteratively designed our prototypes to meet four challenges. The first two challenges are to link the physical space of the building and the works to the documentary space, so that visitors can move between the two. Visitors also need to understand and use 'reading keys' to match an image to the correct subject. Visitors should then be able to use their knowledge and skills on other visits. Our active approach, seems to be appreciated by visitors and helps them to re-mobilise their skills in the short term. Finally, we have discussed other possible approaches. However, the issues raised in this article remain open in other visitor contexts.

To take this further, we want to continue to offer semiotic approaches based on comparison rather than semantic approaches based on description and classification. We want to create itineraries that compare the stained-glass windows of different buildings in order to decipher the keys to reading a topic. We also want to explore the limitations of semantic and semiotic approaches. A stained-glass window, like any other work of art, was created in a specific historical context. So even if the stories remain the same, we can question the relevance of linking or comparing very different contexts.

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