TaggingCreaditor: A tool to create and share content for location-based games for learning

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Abstract— **This paper describes TaggingCreaditor, a content authoring tool for location-based games. This tool is implemented both as a mobile and desktop application, which offers the possibility to end users to easily create, edit and/or mix content for these games. TaggingCreaditor has been designed to support a number of location-based games for learning in cultural heritage sites, based on the idea of connections between digital content and the physical world. Thus, the aim of the reported research was to create a tool that can support the users to customize these games by creating content in the form of textual and multimedia information that can be linked with specific locations or objects indoors and outdoors. In this paper we outline the design rationale and discuss the findings of an initial evaluation study.**

Keywords— game content editor; location-based game; linking game; web-based application

I. INTRODUCTION

In recent years, mobile technologies have come to play an increasingly important role in our lives and new ideas appropriating this technology for various purposes keep emerging. An interesting case is the proliferation of new location-based mobile games, in which the user's location affects game activity. These games often take place in cultural heritage sites where they can contribute to social, experiential and situated learning [1]. They are situated in real-world contexts and are believed to be conductive to learning and to the acquisition of skills like critical thinking, curiosity, creativity, collaboration, social awareness, responsibility and media fluency [6, 7]. The underlying idea is that with these games the players can relate knowledge with physical activities that they perform in the real world, in particular when situated in places rich in historic value, like historic city centers or museums [2]. Examples of collaborative location-based games of this kind are Explore! [4], MuseumScrabble [3] and Frequency 1550 [16].

In this context, the need for TaggingCreaditor emerged, based on many reasons: The first motivation comes from the field of games, game based learning and learning in cultural institutions. Specifically, the latest technological developments have revealed game modification –game modding- as new and creative way of engaging with digital games. Furthermore, studies in game-based learning have showed that learner engagement with modification of game content and characteristics can offer opportunities for rich, creative learning [12]. Similar observations come from museum studies where digital technologies are used to support what is called *participatory cultural experience* i.e. end users generating content and metadata for museums and cultural institutions [13]. Furthermore, recent studies discuss the learning value of engaging museum visitors with creating content for location based games that can be played in cultural institutions [14,15].

A second motivation is that a multitude of location-based mobile games have been designed and developed, while there is virtually an unlimited number of locations in which these games can be played. All these gaming applications need, in one way or another, digital content for each of the locations in which they are played. In addition they need some methods to label all real-world physical elements (e.g. objects, locations, landmarks etc.) that take part in the game (e.g. with QR tags, RFID codes, GPS sensors etc.).

In addition, for each specific location there is often a need to create different content sets, depending on who the target audience is (i.e. school pupils, visiting adults etc.) or on the overall aim of the activity. Usually tools that assist creation or editing of content for these games are tailored to each specific game. This observation lead us to realize the importance of a generic tool that could be used by end users or other third parties to author content for location-based games that aim at supporting learning. An example of such tools from the domain of traditional video games is Valve Hammer Editor for games built on top of Valve's Source Engine [5].

Ideally, such a tool would allow the users to create content for any type of location-based game that challenges the players to link the real world with entities of the digital realm, and allow that game to be played in any location. Such a content editor would allow developers of location-based games to launch their games in a large number of locations, but it would also allow other interested parties, such as educators, curators, or residents of an area to create end-user content for existing games.

The main goal was, therefore, to design and develop a generic application that can function as a tool for creating and editing content for location-based mobile games. In order to achieve this, one of the first requirements was that the tool should support as many location-based mobile games as possible. To meet this goal, the first step was to analyze existing mobile location-based games, with special focus in linking games,

as discussed next. After having analyzed the operation of these games, the next step was to generate a suitable model that would inform the design of the application. Finally, once these steps were carried out and a sketch of the content editor had been designed, the tool was built and tested in an initial evaluation study.

The rest of this paper is organized as follows: First the games are briefly described that were used for the design of the new tool. Next, we propose the model that represents the common features of these games. Next different use cases are described. Then evaluation study of the tool, TaggingCreaditor, is presented. Finally, in the last section we discuss our conclusions and describe the future directions of this work.

II. TYPICAL GAMES

Location-based games

Location-based mobile games involve activities that require players to move in the physical space as part of the gameplay. In these games the players interact with objects in the real world and can perform physical activities within places rich in historic value. As noted in a survey of location-based games [7], these games are conceived as tools that employ the fun of a game, so that the players can be engaged with a specific location. These games are often played using mobile devices that can report the player's position, either via GPS or implicitly by requiring that the player performs an action such as scanning an NFC tag or reading a QR code. Most of the location-based games are developed for mobile phones since these devices constitute a ubiquitously available networked technology.

Linking games

The games that have been used as inspiration for this research involve the linking of elements of the real world with concepts, ideas, or factual knowledge in digital form. Through this, an augmented, mixed-reality setting is defined, where the virtual world can be linked to the real world via the player's actions, according to the rules of the game. The objective of the players of these games is to successfully connect real elements with virtual components. We call this kind of games *linking games*. In order to serve their purpose, the real-world objects of such games have a number of mirror elements that relate with them in the virtual world section. The linking, which is the intersection between the real and the virtual world, occurs through the actions of the player(s). Examples of these actions can be: taking a picture of an exhibit in order to obtain its information, getting close to it and thus triggering a GPS proximity sensor or identifying it by photographing its associated QR code.

Next we briefly describe the location-based games (developed by different researchers of the University of Patras, Greece, over the last 10 years) that have been taken into account for the design and development of the TaggingCreaditor tool.

- *MuseumScrabble* [3] is a location-sensitive multiplayer mobile game for museums. Players scan exhibits in a museum and link them to the correct abstract concept using a hint that is displayed on their mobile devices. Originally, the game was developed for a local history museum in Zakynthos, Greece. In principle the game can be played in other museums or cultural heritage sites if appropriate content is used.

- *CityScrabble* [17] is a location-based game for open areas.

The game rules are similar to those used in MuseumScrabble, but in this case it can be played in any open space such as city centers, archaeological parks or other sites of interest.

- *BMS* [8] is a location-sensitive indoor mobile game, developed for the Benaki Museum in Athens. The game aims to engage visitors (mainly student groups) in a process of discovering relationships between museum exhibits and objects that are not included in the public exhibition.

- *Taggling* [11] is an indoor location based game designed to support learning in an art museum (the Macedonian Museum of Contemporary Art). The game idea involves mixing and relocating virtual tags on the real exhibits. Players raise their score when they place the correct tag on the right exhibit. Thus acquaintance with contemporary art develops through visiting and revisiting the same exhibits and making inferences triggered by the tags and based on observations of the exhibits.

III. ABSTRACTION MODEL OF TAGGINGCREADITOR

The design of TaggingCreaditor was based on desired functionalities and concepts that emerged from the study of the games listed in the previous section. An important aspect of this tool is to support the core authoring activity, so that it can be used to author content for multiple games and ideally for future linking games. A unified model had to be defined, since the games use different terminology to represent similar concepts of physical and virtual objects and the relations between them. To achieve this, the common features of the studied location-based games were identified and the model was laid out as a hierarchy of the main entities of the studied games, as shown in Fig.1. This model is not restricted to a specific game, but aims to cover their common characteristics.

Typically in linking games, the essential real-world objects are exhibits of a museum, or buildings in city centers. In the model's notation these are called *elements*. Similarly, the information that has to be related to them in order progress in the game is called *keys*. The dichotomy between elements and keys represents the dichotomy between the real and virtual domains and is reflected as such in the two branches of the model, as shown in Fig. 1.

At the top, is the entity *Game*. The *real world branch* consists of tangible objects or locations in the physical world, such as exhibits in a museum or buildings in a city center. The *virtual world branch* contains all the content of the game such as pictures of the elements, their textual descriptions, the hints that the players gets and so on. In order to relate them to real-world objects, an *identity* is defined that represents the real-world elements in the virtual world. The *identity* is a unique characteristic that identifies a real-world element. The identity is implementation-agnostic and can be the value of an NFC tag or QR code or the geographical coordinates of said element.

At the bottom of the real-world branch of the model (level 3), we have *elements*. *Elements* can be real-world objects such as paintings, sculptures or any other kinds of objects or exhibits that reside in the real world. In a location-based game, they are identified by their *identity* and they can be linked by a *relationship* with content of *virtual world branch*. That content is organized in entities called *keys*, and it resides at level 3 of the *virtual world branch* of the model. *Keys* can have any possible digital form

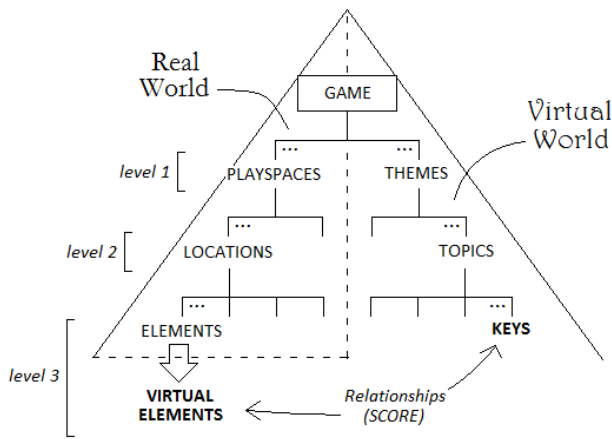and could for example be text sentences, images, videos etc.

Fig. 1: The abstract model on which TaggingCreaditor is based.

At level 2 of the *real world branch* of the model, there are *locations*. A location denotes a distinct physical area where several *elements* are placed and which could constitute a group that is physically proximal, e.g. rooms in a museum, streets or squares in a city etc. At the same time, at level 2 of the *virtual world branch*, the *keys* are grouped in *topics*, which constitute overall conceptual groups. Examples of *topics* can be an epoch, like the XIX century, a specific artistic style, the suffragette movement etc.

Finally, at the top level of the *real world branch* of the model, a group of locations constitute a *play space*. A *play space* could be for example a city or a museum. The equivalent entity in the *virtual world branch*, is called a *theme*, which enables the content editor to organize the level 2 *topics* in broader themes, such as History or Architecture. Moreover, if a more complex game setup is needed, the model can accommodate more than one *play spaces* or *themes* in the same game.

The linking between the *real world branch* and the *virtual world branch* is carried out at level 3 of the model. It consists of a set of possible *relationships* between *elements* and *keys*. *Relationships* are links between entities of the real-world and entities of the virtual world that award credit to a player, if the player establishes them within the bounds of the game.

IV. USE CASE

In this section we describe typical use cases for both an end-user who creates content for a typical location-based game and the stakeholder of the venue where this game is to be played. A teacher is planning to bring a class of pupils to a place suitable for non-formal learning, such as a museum. The teacher is specifically interested in showing to the pupils a section of the whole museum, like the paintings of a specific era. The teacher herself will be creating the content for her own pupils in that museum game. The following scenarios are possible:
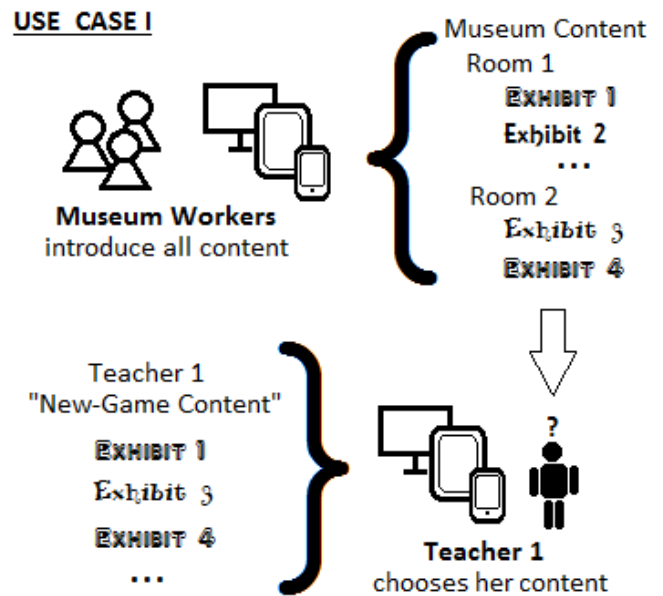

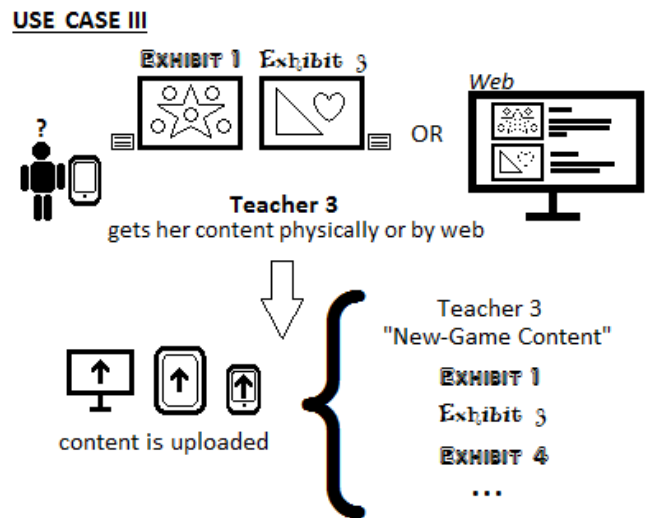**Fig. 2:** Use case I, as supported by the TaggingCreaditor tool.

Fig. 3: Use case III, as supported by the TaggingCreaditor tool

I. The museum creates the descriptions of the exhibits and the teacher selects the virtual content and the possible relationships. The museum staff, by means of TaggingCreaditor, creates a list of the exhibits which are suitable to be included in the location-based game. The exhibits will be represented as entities in TaggingCreaditor (Fig. 1). The teacher, if she wishes, can adapt the content of those exhibits and choose among them the ones she wishes to include in the game session. This scenario is illustrated in Fig. 2.

II. The teacher chooses content that was made previously with the tool and clones it into her game. This game content has been created previously by other users.

III. The teacher creates the content of the game from scratch. To carry this out, she should be familiar with the exhibits,

possibly by personally examining the collection or visiting the museum's web site, with the support of her pupils. The teachers can use TaggingCreaditor to capture and upload data with a mobile device while walking through the museum. She can use the device to mark locations, shoot and upload pictures or submit textual descriptions. Alternatively, the teacher can use a stationary computer from her work place or home via the Web. This scenario is shown in Fig. 3.

The three scenarios are exemplary of typical patterns of use of TaggingCreaditor. The end-user could also combine elements of these three scenarios to create her game content and/or edit only some features of the objects. She can also decide if she wants to share this new content with other users. Game content can be shared in two ways, either by cloning previously created game content and using it as a starting point, or by collaboratively editing content, which means that more people can be working in the same game content at the same time without conflicts. Once this information is stored, the new content resides in the application database, and museum workers need to print and place the exhibits identification tags such as QR codes or NFC tags, if they are needed by the game.

Thus, each user can use TaggingCreaditor to create her own game content, share it with other users and get a feedback later, on how other users have modified it in other games. TaggingCreaditor is not limited to indoor location-based mobile games, but it can also be used for location-based games for outdoor places, as is the case of CityScrabble [17].

V. EVALUATION STUDY AND RESULTS

The evaluation of TaggingCreaditor took place in a usability lab with the participation of 9 university students of different disciplines and nationalities, who acted as school teachers. The participants were asked to use TaggingCreaditor in order create content for two location-based games, CityScrabble and TAnGling, following use case III of the previous section. Pictures of the paintings that are exhibited in the Macedonian Museum of Modern Art were hanged in the rooms and halls of the lab, to be used for creating content for the TAnGling game. Information for CityScrabble concerned the former Athens gasworks, now an open air museum, and was provided in printed sheets of paper. Four researchers participated in this evaluation session. The participants had to create content with both the mobile version of TaggingCreaditor as well as with the desktop version. In the first case they used tablets and smartphones and created the content while visiting and observing the mock exhibits. In the latter case, they used a desktop computer and were provided with printed information about the target location. In Fig. 4 typical screenshots of the mobile version and the evaluation activity is shown.

1) Procedure
The tools that were used for the evaluation session were the think-aloud protocol [9, p. 273], a SUS (System Usability Scale) questionnaire [10] and a moderated discussion between the testers and the researchers at the end of the session.
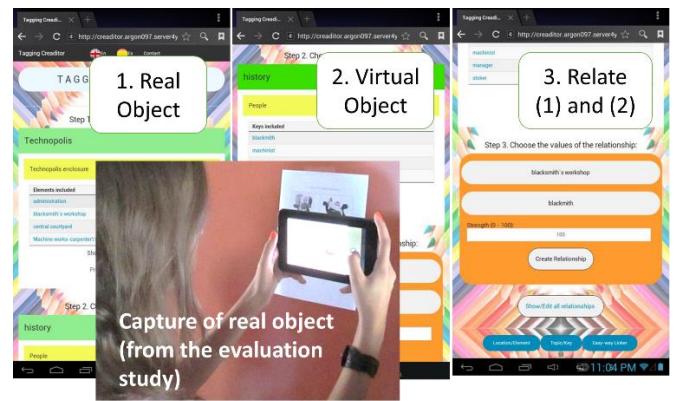

Fig. 4: Screen shots of the mobile version of TaggingCreaditor: (1) Definition of real object, (2) Definition of virtual object, (3) Relationship between the two.

At the start of the evaluation a tutorial video was shown to the participants that contained instructions for using TaggingCreaditor. Next, the gameplay of the two location-based games was explained (CityScrabble and TAnGling) for which the participants had to create content. Next was presented the scenario of use. For both games the participants were asked to impersonate secondary level school teachers with the objective of creating content for a game so that their students could play it in a visit in the near future. In the desktop scenario the participants had to follow the guidelines described in a given document. In the mobile scenario, in addition to that, the participants had to create content with a tablet or smartphone by taking pictures of the items placed on the walls of the room prepared for this purpose (Fig. 4).

The participants were divided in two groups. Group A started with the mobile version of TaggingCreaditor and created content for the game TAnGling. Afterwards, Group A continued with the desktop version and the game CityScrabble. Group B worked in the opposite order. During the evaluation the content for the games was created by the participants by following the steps and guidelines outlined in the given documents. Once the participants finished the tasks, they answered the SUS questionnaire taking into account their experience with the tool. Finally, a semi-structured group discussion was held among all participants of the evaluation in which the participants commented on their own impressions, opinions, problems they found, possible improvements and so on. The group discussion was recorded in video.

2) Results
Analysis of the evaluation was based primarily on the semi-structured group discussion, the researcher's observation notes, and the answers of the SUS questionnaire. The recordings of participants think-aloud protocol were used ancillary. The SUS questionnaire provided feedback about the usability of the application and the group discussion allowed us to consolidate the opinions of the participants and the researchers.

Regarding the SUS questionnaires, both the mobile and the desktop versions got acceptable scores, namely 75 points for the mobile version and 78 points for the desktop version, out of 100. The obtained values are calculated as indicated by the SUS

methodology [10] and show that there are no significant differences between the two versions (desktop and mobile). Both of them reflect a quite positive impression.

Most of the participants of the moderated group discussion agreed that the ability to create on their own content for location-based games that are used for learning is useful and also that the application is of interest since the same application, TaggingCreaditor, could be used in order to create content for multiple games, in their case for CityScrabble and TAnGling. They found that the interface was intuitive, both in the mobile and desktop versions. They also highlighted that the desktop version is easier to use than the mobile one. But conversely, creating content from the mobile version is more entertaining than the desktop version because through it they could interact directly and on location with the elements that take part in the game.

VI. Conclusions And Future Work

In this paper we have presented a web-based tool for both mobile and desktop setting that is able to assist users in creating content for a variety of collaborative location-based mobile games. The tool is flexible, generic and it can be used in a collaborative way, since anyone can be the user and the creator of her own content which can then be reused by other users. In this section we discuss directions for future work with TaggingCreaditor.

- *Multi-session user support:* Although the application does allow the simultaneous use by multiple users, it does not provide isolated content space that is separately from the other users. TaggingCreaditor provides instead a common workspace, equally accessible from all users. This is a deliberate design decision but a possible enhancement could introduce the possibility of isolated user spaces.

- *Uploading a user's map:* A possible enhancement in the application would be to include and use user-created location maps. Thus, users would have the options to include their own map or use the default Google map. Users could introduce a drawing or sketch of a museum map so that the content creator could locate the physical elements of the museum on this map.

- *Wizard assistant:* The evaluation findings suggest that a wizard interface would make it easier for new users to create content for a game. Such an interface would guide the users step-by-step while they create content in the content editor.

-*Rules modification*: While in its current form the application modifies the content of the game, in terms of physical objects, themes and their relationships, it does not affect the rules of the game. A future direction would be to define a model for rules and mechanics of linking games and to be able to modify them together with the content.

Acknowledgment

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