Magical Board Theatre: interactive stories that can be played on multiple boards – two educational prototypes

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Abstract. Interactive storytelling uses in education are limited by the time required for its production and the ephemeral nature of interaction systems, leading inter-active stories to have a short usefulness life. We have developed the concept of platform-independent interactive stories, called virtual choreographies, enabling interactive stories to be replayed on novel technological platforms as they emerge, tackling the second half of this problem. The first part was also approached via a graphical storyboarding approach. Both aspects have been prototyped in a demonstration, called Magical Board Theatre ("Teatro de Tabuleiro Mágico", original Portuguese name). We present this prototype, including its storyboarding tool, summarize the virtual choreographies ap-proach, and demonstrate how the prototype operationalizes them with story and platform examples.

Keywords: board games, digital storytelling, xAPI, interactive storytelling, virtual choreographies, multiplatform

1 Introduction

People's immersion with stories, be they in novels, movies, or other media, surpasses the industry's ability to produce them. This is apparent from phenomena such as fan movies, which are now part of con-temporary popular culture, and an intertextual tendency across media, permeating social culture [1], originating the concept of Transmedia Storytelling [2]. When stories are made interactive, they become yet a further medium, one that emerges from the intertwining of the agency boundaries embedded in the story by its creators and the agency exercised by the actual people engaging with it. As Neves et al. put it for videogames, one genre of interactive storytelling, "the game as a system and the player of the game carry out speech acts whenever play happens – the player plays in the terms of the system and the system is designed to enact those terms and to implicitly transmit what those terms are to the player" [3].

In education, these dimensions of immersion – absorption in the narrative, and absorption with challenges in interaction [4] – are a rich and powerful technique for engaging with core ideas, self-reflection, and other impactful dynamics of learning

[5]. The production of interactive multimedia content, in a creative and passionate context, is a mindtool, as Jonassen put it: "to engage learners in thinking deeply about the contents they are studying" [6]. However, production processes can be time-consuming, to the point of their feasibility in educational contexts being put into question [7]. Further, interactive digital stories are often ephemeral media. The modes of interaction and the rules that effect it are inextricably bound to a technological platform. Once that platform is rendered obsolete, its stories become unplayable, lost to memory, unless enough public enthusiasm manages to develop simulators for those platforms, which further limits the adoption of interactive storytelling in education.

Here, we present an approach devised to tackle this two-pronged problem, by combining interactive multi-platform virtual choreographies [8] that preserve stories across platforms, and visual storyboarding in a strict context, to diminish the time requirements for creating stories. This approach was implemented in the Magical Board Theatre prototype and tested with sample stories.

2 The Magical Board Theatre concept

Magical Board Theatre ("Teatro de Tabuleiro Mágico", original Portuguese name) is a prototype platform for tabletop storytelling. It implements our approach of combining 1) easy of story creation with visual tools and 2) keeping interactive stories independent from their replaying platforms. In this sense, the Magical Board Theatre accepts multiple theatre "boards" with their own theatre "pieces" and "theatricals": animated characters, static elements, area highlights, etc. These boards are not just obsolescence-prone visuals and code: each must include a semantic description of its theatrical affordances. This means that each board is seen as a specific, independent platform, and its semantic description, the "platform recipe" is a key element in the approach as described in the following section. In this paper, we exemplify this operation with two stories and their replay in different platforms without user intervention.

3 The Virtual Choreographies technique

3.1 Concept

Multi-platform virtual choreographies are the technique we leveraged to preserve stories across platforms, by rendering it interactive and definable by end users. Its core concept is that behaviours within a scene, of actors, objects, scenario properties, etc. form a "virtual choreography". This choreography is expressed in that scene's own thematic semantic space or "platform-independent & domain-dependent" ontology: for instance, mechanics using screwdrivers are expressed as such, not as "avatars using objects" or some other platform-specific construct [9]. Platform affordances are similarly described agnostically, in a "platform-dependent & domain-independent" ontology. By mapping such ontologies to each other, automated transformations

translate a virtual choreography into that platform's specific concepts, enabling it to be replayed without reprogramming (ibid.).

Fig. 1. Virtual Choreographies method to enable stories to be platform-independent [8]

However, authoring of choreographies as instantiations of ontologies is a complex process. We used the recent xAPI specification [10] to update the original virtual choreographies technique [9]. In brief, following xAPI all stories are sequences of statements, with a standard structure: actor, verb, place, object, and context. Thus, ontologies only describe the semantic space of such statements ("story recipe"). And platform ontologies ("platform recipe") are also based on these structural elements. By matching a story recipe with a platform recipe, any choreography written using that story recipe can be re-played on that platform. Conversely, if a new platform provides its recipe and its matching with an existing story recipe, all stories writ-ten using that recipe can be replayed on that platform (**Fig. 1**).

3.2 Adding interactivity

The original approach [8] enabled interactivity, because since each story was itself an ontology, an inference engine could react to environment changes, produced by a user or some other agency. However, that approach did not consider explicit prompts for interaction, which is a common mechanics in interactive storytelling. For instance, in

the first interactive video story, Kinoautomat [11] a moderator would regularly ask the public to choose among options that would conduct the narrative. In paper form, the same concept became popular culture in the 1980s through interactive books in series such as “Choose Your Own Adventure” and “Fighting Fantasy”[12]. The concept remains active today, with significant media exposure given to the interactive movie Bandersnatch on Netflix [13].
We have implemented interactive storytelling into our approach by considering that specific actors can be responsible for providing options and choosing. For instance, a story recipe can have a “Narrator” actor to enable stories to present options out of the blue (without having to assign the provision of options to a proxy character). Similarly, story recipes can have an “User” actor, to enable stories to express the concept that the storytelling needs to wait for a user input. Since xAPI statement sequences do not hold world state, we re-act to these interactions by explicitly expressing storylines in the story, as contextual outcomes of those decisions, within the “Context” section of each xAPI statement.

4 Storyboard Editor and Recipe Matcher

The visual storyboarding tool aims to enabled non-expert users to create stories, i.e., virtual choreographies. Firstly, the story author must choose a specific story recipe or provide a new one. It is the semantic space of that story recipe that determines the possibilities made avail-able in the storyboarding tool: actors, verbs, places, contextual items, etc. The tool then operates by leveraging traditional interaction approaches in the field of interactive narratives, such as Twine [14]: story statements are presented as individual blocks, which can be connected to each other as a graph (**Fig. 2**). Interaction moments originate a storyline fork in the graph, which can be kept or eventually joined at some later story point.
The resulting graph is then serialized into a JSON file, following xAPI.

Fig. 2. Connecting two statements (left), and a story graph (right).

The same graph-based tool is also used to match story recipes with platform recipes. For instance, a disjoint set of blocks representing the actors in a "Star Wars" story recipe can be connected to another disjoint set of blocks in a board platform recipe. For instance, Actor "Darth Vader" (story recipe) can be mapped to Actor "Black Knight" (castle platform recipe) or to Actor "Batman" (comics platform recipe). As another example, a verb such as "Go to" in a story recipe can be associated with "Move" in a 3D board platform, but with "Change comic strip background" in a comic strip board platform, since that's how actors "go" somewhere in a comic strip.

5 Three replaying platforms

As a proof of concept, four platforms were created:

1. a comic strip platform;
2. a 3D fantasy castle;
3. a game room with a tabletop map of the Iberian Peninsula;
4. a game room with a tabletop diagram of the periodic table.

Each platform includes its own media resources, such as characters, visual environment, audio materials, etc. as exemplified in Fig. 3.

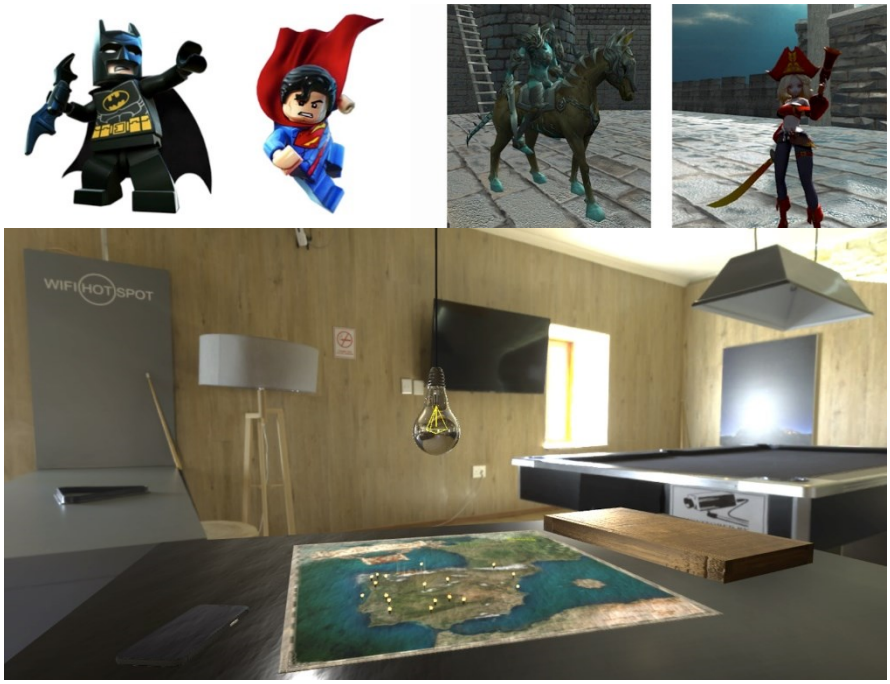

Fig. 3. Sample Magic Board Theatre media resources: superheroes in the comic strip platform, knight and woman pirate from the castle platform; and visual environment of the game room platform, with the tabletop map of the Iberian Peninsula.

6 Sample Story Recipes and Stories

6.1 Story Recipe 1: Star Wars universe

Our first trial with story recipes was inspired by a sequence from the movie Star Wars: The Empire Strikes Back [15]: the famous "I am your father" occasion, when the Darth Vader characters reveals this to the main protagonist, Luke Skywalker. This scene has been reimagined numerous times in alternative media, narratives, and popular culture (**Fig. 4**), which led us to consider how a recipe could be built to enable creators with the freedom to create those various reinterpretations.

Fig. 4. Sample "I am your father" reinterpretations found in online media

The entire scene was idealized for a single location, known as Cloud City, as indicated in its storyboard (**Fig. 5**). We have two characters, dialogue, and some movement, hence the recipe shown in **Fig. 6**.

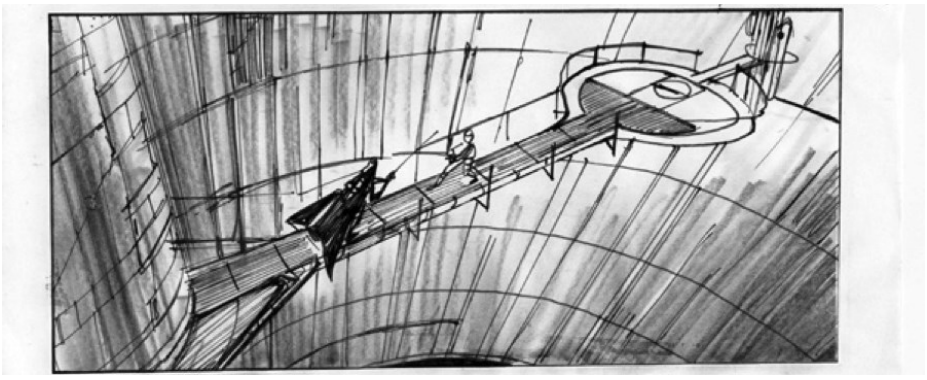

Fig. 5. Duel on Cloud City storyboard,
http://theswca.com/index.php?action=disp_item&item_id=48231

The recipe has one actor for each character: "Luke Skywalker" and "Darth Vader". One place, the location "Cloud City". And three verbs, for being at; going somewhere; and speaking. There is a context element: the content of speech. We might have considered other context elements, such as stance for motion, emotional cues, etc.

```
{"starwars": //recipe name
      {"Actors":["luke_skywalker","darth_vader"],
       "Places":["cloud_city_core"],
       "Verbs":["IsAt","GoTo","Speak"],
       "Context":[{"Content":"text"}]}
      }
```

Fig. 6. Story recipe for "I am your father" reinterpretations

With this recipe, countless virtual choreographies (stories) can be created. A sample choreography is shown in **Table 1**, just with speech.

Table 1. xAPI statements reinterpreting the "I am your father" scene.

Statement 1		Statement 2		Statement 3	
Actor	Darth Vader	Actor	Luke Skywalker	Actor	Darth Vader
Verb	Speak	Verb	Speak	Verb	Speak
Place	Cloud City	Place	Cloud City	Place	Cloud City
Context: Content	Obi-Wan never told you what happened to your father?	Context: Content	He told me enough. He told me you killed him!	Context: Content	No, I am your father!

The actual rendering of this story will depend on the platform. The recipe simply enables stories to be told acknowledging these actors, verbs, place, and contextual elements. For instance, a platform might use the indication of "Actor: Darth Vader" to decide on a visual representation, an audio timbre, a specific text font size, or some more complex combination of elements. The platform will have its own elements, and it's the matching process (described later) that will map a story recipe's elements to a platform recipe's elements. The choreography is always expressed in the terms of the story recipe, and the platform-adapted choreography, generated automatically, is the one executed by the platform, on its own terms, and with its own media resources and rules.

6.2 Story Recipe 2: Portuguese "Reconquest"

For our second trial, we considered the educational context of a piece of Portuguese History, the so-called "Reconquest" period of political and military instability between opposing social formations. It refers to a long period of time between the VIII and XIII centuries, of major activity from "Christian" kingdoms against Muslims who were established in the Iberian Peninsula at the beginning of this period. It's not an unequivocal name, since it contains multiple perspectives on economics, politics, society, and culture, far more complex than a simplistic notion of conflict among homogenous blocks or unidirectional advance of one side "recovering" land [15]. The

apologetic and somewhat triumphalist character of chronicles about this period tend to diminish the multiple ebb and flow inherent to the occupation of a territory that would become the kingdom of Portugal, as well as ignoring the multiple alliances between Christians and Muslims in different fighting contexts.
The process of resettling lands and power exchanges after various conquests of cities within current-day Portuguese territory can be exploited visually to support a better grasp of these dynamics. A particularly visible dynamic is the successive conquest and loss of territory and cities in the XI and XII centuries over the "Mondego line", up until Portugal's independence was asserted in 1143.

Thus, we considered how a recipe could be built to enable creators with the freedom to create various stories of the Portuguese Reconquest dynamics, which we presented in shortened form in **Fig. 7**.

```
{
 "Reconquest":{
 "Actors":["knight", "traveler", "crusaders"],
   "Places":["Lisbon", "Oporto", "Coimbra", "Cadis"],
   "Verbs":["is", "go", "dialog", "choose", "hide",
"play"],
   "Context": [{"content":"text"}, {"url":"text"},
{"storyline":"text"}]}
}
```

Fig. 7. Shortened version of the Reconquest story recipe.

Like with the "I am your father" recipe, choreographies (stories) can be created with this recipe. Instead of using a table, we present a story following this recipe serialized in JSON format in **Fig. 9**, and an example rendering in **Fig. 8**.

Fig. 8. Story of **Fig. 9** being played in platform 3: game room with a tabletop map of the Iberian Peninsula.

```
{
   "actor":"knight",
   "verb":"dialog",
   "place":"Cadis",
   "context":{
      "content":"In the year 711 the Moors invaded the
Iberian Peninsula, from Gibraltar.",
      "url":"https://site/in-711-invaded.wav",
      "storyline":"intro"
   }
},
{
   "actor":"traveler",
   "verb":"dialog",
   "place":"cadis",
   "context":{
      "content":"And what happened?",
      "url":"https://site/and-what-happened.wav",
      "storyline":"intro"
   }
},
{
   "actor":"knight",
   "verb":"dialog",
   "place":"cadis",
   "context":{
      "content":"The BATTLE OF GUADALETE – The Moors won
and it was the end of the Visigoth Empire.",
      "url":"https://site/guadalete-battle.wav",
      "storyline":"intro"
   }
```

Fig. 9. Virtual choreography (story) based on the Portuguese Reconquest story recipe

7 Matching recipes and playing the stories across platforms

7.1 Matching story recipes with platform recipes

In order for a virtual choreography (story) to be playable on a platform, a match must be created between the story recipe followed by that choreography and the platform recipe providing the semantic space of the platform affordances. This can be a plain 1-on-1 match, as shown on the following tables, but using the xAPI context element, we can also provide specific rules for each match. For instance, assume that a platform only has a single character, but enables it to be rendered alongside text: the context element for the matching of “Luke Skywalker” with “Default Character” could

establish the text “Luke Skywalker” as context, and the platform could then use that text as overhead text to distinguish that character from other visually identical ones. A similar approach could enable the matching with non-visual platforms, such as text adventures or others.

Table 2. Matching the “I am your father” story recipe with platform recipes 1 and 2

Story recipe: “I am your father”		Platform recipe 1: comic strip platform		Platform recipe 2: 3D fantasy castle platform	
Actor	Darth Vader	Actor	Batman	Actor	Knight
	Luke Skywalker		Superman		Pirate
Verb	IsAt	Verb	Show	Verb	Be
	GoTo		ChangeBack		Move
	Speak		Balloon		Talk
place	Cloud City	place	Factory	Place	Castle

The comic strip platform will play the stories replacing Darth Vader with Batman and Luke Skywalker with Superman. The verb for being at some place is simply used to tag a character as being visible in upcoming scenes and the verb for going somewhere is converted into background changes. Speaking becomes showing a speech balloon. This enables stories following this receipe, like the story in **Table 1**, to be rendered in this comic strip platform, as shown in **Fig. 10**.

Fig. 10. The story from **Table 1** rendered in platform 1, via recipe matching.

Similarly, the matching of the story recipe with the platform recipe for platform 2, the 3D fantasy castle, enables the outcome shown in **Fig. 11**.

Fig. 11. The story from **Table 1** rendered in platform 2, via recipe matching.

We have similarly matched the story recipe with the tabletop platforms (3 and 4), resulting on successful renderings. **Fig. 12** shows how "I am your father" is now the revelation done but the Crusader character to the Traveler character in this platform.

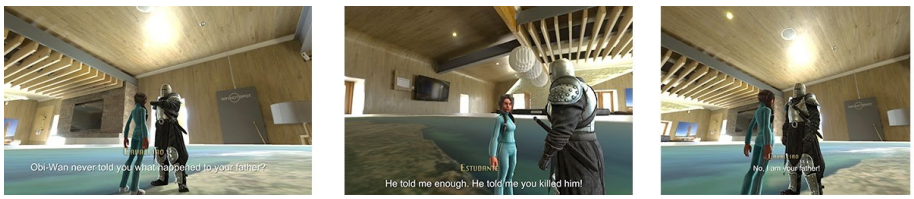

Fig. 12. The story from **Table 1** rendered in platform 3, via recipe matching.

8 Conclusions

We have presented a system that enables stories to be played across multiple platforms, without requiring recoding. The approach of turning xAPI on its head from documenting events to specifying events was successful and can be a powerful technique against obsolescence of interactive storytelling. Even though this occurs with semantic approaches, the visual storyboarding tool enables the creation of semantic stories to be done by non-expert users, thus potentially empowering teacher and students alike to participate in engaging the educational community in this new medium.

Further work exploring the feasibility of the interactivity approach described in the paper is still required, as is exploring the feasibility of further platform types. For instance, considering automated interactive video generation of stories, with adequate intelligence for deciding on camera movements based on story elements, would enable yet another pathway for future enjoyment of interactive storytelling.

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