Making sense of collaboratively annotated Multimedia Metadata for (mobile) digital Story-Telling and Educational Gaming

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Abstract. Technology enhanced learning (TEL) is considered a key element for lifelong and cost-effective learning processes. Nowadays, with the rapid development and evolution of the Web 2.0 (e.g. wikis, blogs, etc.) new learning paradigms have emerged. Instead of a simpler model where students consume instructor-written documentation, it appears to be a natural process that users (or learners in this case) may become a *prosumer* (a combination of producer and consumer). In the context of TEL this implies the creation of a new species: The *teaner* (a combination of teacher and learner). Additionally, TEL is now exploring alternative forms of content such as story-telling and educational gaming. These two approaches, when combined, can be mutually beneficial, with games bringing the educational stories to life and with the stories providing a solid narrative backbone for the games. In this work, we propose an approach to merge educational gaming, interactive story-telling and collaborative creation of content, glued together by interoperable multimedia metadata. Finally, we discuss aspects of mobile learning and the challenges posed by adding a fourth dimension for the problem: letting *teaners* go mobile.

Keywords: Story-telling, Educational Gaming, Multimedia, Metadata, Mobile Devices

1 Introduction

The advent of a new Web 2.0 spirit can have a great impact in the creation of educational contents with s low cost. More and more people are willing to provide contents free of charge as they share their expertise via various social software platforms such as blogs, wikis, videologs, etc. When these trends enter educational contexts, a Web 2.0 *prosumer* (combining the roles of content producer and consumer), becomes a *teaner* (combining the roles of teacher and learner).

However, not every *teaner* will always be "talented" in providing us with potentially useful and interesting contents, a task that becomes harder and harder as the contents grow in complexity. An example would be the collaborative annotation

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of educational content when combining digital story-telling and educational gaming. Hence, it comes to us – as the system developers – to provide all the many producers in with methodologically sound tools to provide suitably annotated contents for digital story-telling and educational gaming. Based on these metadata annotations, we will then be able to re-use these contents and transform them for being used in the one or the other application.

In this paper we first give an overview on metadata standards for digital story-telling and educational gaming. Then, we introduce related approaches to story-telling and educational gaming and analyse their usage of multimedia metadata. After that, we present our *teaning* (a combination of teaching and learning) case study metadata interoperability in story-telling and educational Gaming. In a next step, we discuss the additional challenges that emerge when we introduce a new mobility factor into the process, identifying the requirements for *mobile teaning*. Our paper ends with a discussion of the conclusions and an outlook on upcoming research.

2. Metadata standards for education

A very strong trend in TEL is the application of the Learning Objects Model (LOM) [1]. The model proposes the organization of learning contents as self-contained units that can be assembled to create bigger courses. However, for this model to work, it is necessary to package and annotate these learning objects in a standardized way.

In particular, the annotation is performed using standardized metadata that facilitates the reusability of the contents, because it allows content-creators to describe the learning objects so that they can be applied in appropriate contexts without having to review the content in detail. However, there are many forms and standards to describe metadata. Some were proposed for different applications, and some are directly competing formats. However, even the most specific-purpose standards end up having a certain degree of overlap. The result is that there is not a single and unified approach to annotating educational contents. In this section, we provide an overview of some of the different metadata schemes that may have an impact when it comes to annotating interactive educational content.

2.1. Dublin Core

Dublin Core (DC) is a metadata standard that has been developed by the Dublin Core Metadata Initiative [2]. The standard aims at improving the search of retrieval of web contents by providing adequate descriptors. The basic Dublin Core Metadata Element Set (DCMES) consists of 15 metadata elements: *Title*, *Creator*, *Subject*, *Description*, *Publisher*, *Contributor*, *Date*, *Type*, *Format*, *Identifier*, *Source*, *Language*, *Relation* and *Coverage*. Each of those elements has certain properties according to the standard definition: each element is optional, may be repeated and there is no prescribed order to use them.

However, this standard was neither designed to describe temporal and media-specific information connected with multimedia resources, nor to describe education-specific characteristics of the content. In general, it is also possible to combine DC

with other metadata schemes, as the ones that we describe below. However, there is a risk that the so-created metadata are misleading given that there is an overlap among the different schemes.

2.2. IEEE LOM

The IEEE LOM standard [3] is a data model used to describe learning objects and similar resources used in e-Learning. The standard was specifically designed to support the reusability and interoperatibility of the learning objects (LO) within the context of Learning Management Systems (LMS) by providing a structural description of the LO. The IEEE working team who developed the LOM standard defines a LO as *any entity, digital or non-digital, that may be used for learning, education or training*. In this sense, the IEEE LOM standard is more specific than DC metadata, and much more detailed.

The standard defines 74 elements (none of them mandatory) organized in nine categories: *General, Life Cycle, Meta-Metadata, Technical, Educational, Rights, Relation, Annotation, and Classification*. Even though the standard does not require it, the metadata are usually encoded in XML using the XML binding provided along with the specification.

2.3. MPEG-7

The XML-based metadata standard MPEG-7 was developed by the moving pictures expert group (MPEG) [4]. The first version was released in June 2001 (ISO/IEC 15938). MPEG-7 provides means to store metadata about multimedia contents [5-6]. With full independence of the media storage format, MPEG-7 offers the most comprehensive pallet of descriptions for audio-visual materials on different levels of granularity [7]. The Multimedia Description Schemes (MDS) are at the core of the MPEG-7 standard, providing the segment description of the schemes that include useful definitions for our needs, in order to store all the metadata about multimedia artifacts. Each basic element contains specific descriptors and data types that are usable in all MPEG-7 schemes and therefore, are a flexible and powerful tool for the creation of metadata.

3. Survey on Multimedia Metadata usage in Story-Telling and Educational Gaming

An interactive environment for emergent story-telling is StoryWriter [8]. The idea of StoryWriter is the creation of text-based and illustrated stories. The authors of stories are guided by rules that e.g. manage the interaction between characters. StoryWriter is neither web-based nor collaborative.

An application of group story-telling in knowledge management is TellStory [9]. It is a collaborative, web-based application that allows a group of users to jointly create a text-based story. Its collaboration-oriented approach is valuable and relevant from a

teaner-produced content perspective. However, TellStory is text-based only and does not support the usage of multimedia. StoryMapper is an approach to group-based story creation [10]. The collaboration process is guided by user roles (i.e. teller, organizer, associator/indexer and listener). For visual representation StoryMapper supports the use of conceptual maps and arbitrary media can be attached to the conceptual map nodes. Thus, StoryMapper is capable of modelling expert experiences within stories. Another approach towards group story-telling for team awareness and entertainment is PhotoStory [11]. Group members may create stories jointly, which consist of pictures and their subtitles. The system is based on BSCW [12] and supports community collaboration and knowledge exchange according to the BSCW methodology. However, its current implementation only supports photos. An approach to retrospective story-telling with digital photos is iTell [13]. In this aspect, iTell is in line with the intention of story-telling to support learning by sharing expertise within communities. iTell supports a 4-ary creation process (brainstorming, organization, writing and media association) including photos as well as voice recordings to be associated with linear text-based story.

Collaborative Audio-based Story-Telling is an approach focused on audio and its text-based metadata [14]. The system is also suitable for modelling non-linear media dependencies. However, collaborative audio-based story-telling does not support any other media and the application of the stories for educational gaming is not considered.

Regarding the development of educational games, the field is very broad, as there are many different approaches to game development. In the context of collaborative work, the contributors cannot be expected to have programming knowledge. Therefore, our survey should focus on game-authoring tools. Most of these tools are actually commercial products targeted to amateur game developers, without a specifically educational purpose. Such is the case of *The FPS Creator* or *The 3D Game Maker*, both developed by *The Game Creators*. On the other hand, *Mission Maker*, distributed by *Immersive Education*, has a more educational focus, but it is still a commercial product. The Game Maker, currently marketed as a commercial product, has an academic origin [15] and has been used in other academic research projects related to educational gaming [16]. Also relevant, we find the *Alice* project, developed by Carnegie Mellon University. Even though it was designed to be a first contact with Object Oriented Programming, its spin-off project, *Storytelling Alice*, matches our intention of combining story-telling and educational gaming.

Summarizing, none of these tools considers any form of educational and/or multimedia metadata for learning. Even more, none of these platform suits the needs of *teaning*: The creation of structurally consistent and interoperable learning contents.

4. Metadata Interoperability for *Teaning*

The advent of the Web 2.0 has changed Technology Enhanced Learning dramatically. While social software platforms such as blogs, wikis, videologs, etc. become more and more important for long life learning, the strict divide between teachers and learners blurs. These media simply allow all the participants to become *teaners*, regardless of their skills. In this context (at least) two challenges can be identified:

- *Teaners* need to be provided with adequate tools that help them to create (at least structurally) useful contents
- Metadata interoperability is required to transform contents from one *teaning* application into the other

Hence, it comes to us in order to make *teaners* create suitably annotated contents for Technology-Enhanced Learning. Even more, we have to ensure that these contents can be interpreted within different *teaning* applications. The challenge is proportional to the complexity of the contents, and aspects such as non-linear story-telling or educational games rank among the most complex forms of educational content.

In the following subsections, we will present a case study describing the metadata interoperability between a non-linear story-telling environment developed at RWTH Aachen University (called MIST) and an educational gaming platform (<e-Adventure>) developed at Complutense University.

4.1. Metadata usage in Story-Telling: MIST

Generally speaking, media theory assumes that story-telling is the base for passing on/ transferring knowledge through centuries in all civilizations. But nowadays, the amount of information increases in a way that the access to certain knowledge is getting more complicated.

In addition, all people can contribute their experiences and that these experiences can be reused in several contexts, which is the core idea behind Web 2.0. The MIST story-telling framework [17], which stands for Media Integrated Story-Telling, takes these ideas and allows cooperating groups of users to collect different kinds of media and reassemble them to new meaningful units, stories.

A powerful strength of MIST is its non-linear story-telling concept that allows the creation of a story with various possible paths. This could be used to present different perspectives on the same manner. On the consumer side, recipients can decide in which way to continue a story path by branching. MIST is therefore suitable especially for situations, where users want to illustrate distinct scenarios.

MIST uses comprehensive metadata as well as rich semantic annotations of each media unit, enabled by the application of MPEG-7. This improves the search for adequate media within MIST, since users got more possibilities to express what there are looking for. In a sense, through the amount of metadata, the media search is more adequate towards the human way of thinking, which also links pieces of information with several connections. It is worth emphasizing that MIST is not limited to the reuse of multimedia data alone, but can also reuse whole stories in order to tie in with them and utilize them in a completely different context.

As mentioned above, there is a need to develop suitable methodologies to support *teaners* in the creation of meaningful and reasonable content. Therefore, the Movement Oriented Design (MOD) paradigm [18] is implemented in MIST to “remind” story creators that the story itself as well as each sub story part needs a suitable begin to introduce, a main part to tell something and eventually an end to conclude, for example. Following the MOD paradigm, the educational artefact needs to define a context. Without this link between the artefact and the context, the process

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of learning is not possible as the situational background of its creation might not be understood correctly.

Table 1. Metadata in MIST

MIST metadata usage

```
<xs:element name="metadata">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="creator">
        <xs:complexType>
          <xs:simpleContent>
            <xs:extension base="xs:string">
              <xs:attribute name="id" type="xs:string" use="optional"/>
            </xs:extension>
          </xs:simpleContent>
        </xs:complexType>
      </xs:element>
      <xs:element name="creationDate"/>
      <xs:element name="lastUpdate"/>
      <xs:element name="basedOn" minOccurs="0"/>
      <xs:element name="title"/>
      <xs:element name="description"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
```

4.2. Metadata usage in educational games: The <e-Adventure> platform

The <e-Adventure> educational game platform was developed to support the application and general acceptance of educational gaming. First, in order to increase acceptance and reduce development costs, it was designed as an instructor-oriented game authoring environment [19]. Second, in order to facilitate the integration and deployment of the games, the platform was designed to facilitate the integration with Virtual Learning Environments [20].

The platform considers the possibility of packaging and annotating the games as standards-compliant Learning Objects using IEEE LOM metadata to annotate the packages. The information is added to the game from the <e-Adventure> editor as displayed in figure 1.

4.3. Metadata conversions: *Teaning* with Story-Telling and Educational Gaming

Alternative forms of content for TEL such as story-telling and educational gaming can enhance the learning process. If combined, their potential is increased even more as they can light up the *teaners'* imaginations and open up new approaches. Especially in this cooperation, the non-linear conceptualization of MIST works hand in hand with the scenario based <e-Adventure> editor, where sub-stories of MIST's story branch can be mapped to different scenarios in an educational game. A case is

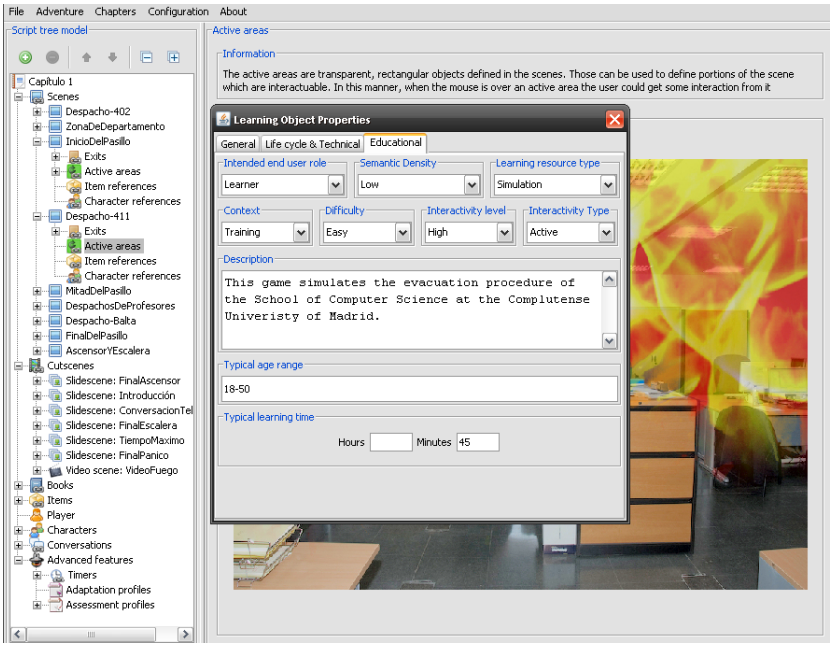

Fig. 1. <e-Adventure> editor annotations of an educational game with IEEE LOM metadata.

conceivable, where a story introduces and prepares recipients, who afterwards dive into a suitable educational game, created out of the story.

In this sense, MIST is capable of exporting stories to <e-Adventure> educational games through a semi-automatic process that turns the story into a game skeleton that can be later refined using the <e-Adventure> editor [21]. However, this conversion was soon found to be lacking in terms of metadata interoperability. As we see in the section 4.1, MIST uses Dublin Core and MPEG7 at both the story and individual resource levels. Combining both standards, it is possible to avoid some limitations in DC (as the lack of temporal and media specific annotations) as well as using the sophisticated description elements in MPEG7 Concretely, the metadata in MIST store information about *Creator*, *CreationDate*, *LastUpdate*, *BasedOn*, *Title* and *Description*. The multimedia information is stored in the field *mediaUri*.

On the other hand, as we mentioned in section 4.2, <e-Adventure> uses IEEE LOM metadata to describe the complete games. Regarding resource-level metadata, <e-Adventure> does not consider that level of granularity. In order to combine both tools, there is a need to combine and adapt the metadata approaches so that no inconsistencies appear.

On the story/game level, the metadata provided by both platforms is complementary. MIST provides useful generic information about the content, while the metadata provided by <e-Adventure> specifically focuses on educational aspects. On the individual resource level, we have extended the <e-Adventure> platform to support the resource-level metadata provided by MIST. Following a flexible approach, that would not require a major rewrite of metadata handling on the <e-

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Adventure> side, the idea is to *link* the individual resources in <e-Adventure> to external metadata files provided by the MIST platform.

The <e-Adventure> DTD was therefore extended with two new fields that improve the handling of resource-level metadata (Table 2): The field *md-uri* in the *asset* element (that identifies a single resource) indicates an external file where there is metadata about the individual resource (i.e., an XML with MPEG metadata). ID tell us which entry in the external file corresponds to this asset, and, in principle, there are no restrictions on the metadata format followed in the external file.

Table 2. Resource definition in <e-Adventure>. The fields id and md-uri are used to identify external sources of metadata for individual resources

<e-Adventure> DTD
<!ELEMENT asset EMPTY> <!ATTLIST asset type CDATA #REQUIRED uri CDATA #REQUIRED id ID #IMPLIED md-uri CDATA #IMPLIED >

5. Adding another step: Mobile teaning

As it has been described in the previous sections, combining collaborative story-telling and educational gaming is a significant challenge. And even if we are only starting to tackle its complexities, we need to keep an eye on the additional requirement of allowing *teaners* to go mobile. Technology Enhanced Learning and the Web 2.0 are quickly becoming mobile, and educational gaming and story-telling should not be left behind.

Indeed, both MIST and the <e-Adventure> platform are currently being ported to mobile environments. And when we add mobile devices to the mix, there arises the need to define new metadata to reflect the mobile end-devices, capabilities and features of terminals and other data that allow us to make decisions for adaptation in the learning process. It is a third category of metadata to bear into account and interoperate between the applications.

Despite the fast development of mobile platforms in recent years, these still suffer from a lack of standardization and interoperability in most levels. In many cases it is necessary to adapt the content depending on the device that displays it, which is a complex problem in itself. For years, most providers devices have fought each other for achieved the supremacy, which has resulted in a wide range of different standards at hardware, software and network protocols.

Regarding the metadata standards already being used in MIST and <e-Adventure>, CanCore is an application profile for IEEE LOM that provides guidelines to facilitate the implementation of pedagogical metadata using a subset of the elements defined in LOM. Due to the nature of this application profile, the description of the multimedia content which is going to be accessed from a wide variety of devices (including mobile devices) can be easily done. MPEG7 can handle the multimedia aspect of

mobile end-devices, but there is a shortage when we tried to handle matters relating to the hardware. MPEG21 offers a very complete set of specifications to describe the characteristics of hardware device. The latest version specifies tools for the description of the usage environment. The usage environment includes the description of *User characteristics*, *terminal capabilities*, *network characteristics* and *natural environment characteristics*.

6. Conclusions and future work

The work described in this document provides the information about the metadata used in three different applications, as well as how the interoperability between this data is ensured and the challenges presented.

Simply combining story-telling and gaming platforms is an affordable task, as the previous work with MIST and <e-Adventure> suggests [21]. However, achieving a deeper integration with metadata interoperability proved to be a more significant challenge as described in this work. Still, our progress so far is limited to the desktop versions of both platforms. However, both MIST and <e-Adventure> are currently exploring mobile scenarios. Achieving these levels of interoperability for the collaborative creation of story-telling and educational gaming in mobile scenarios (*mobile teaning*) will be even more challenging. The techniques described in Chapter 5 are a good starting point. The metadata should reflect the nature of mobile devices based on standards commented, to carry out this task on an efficient way

However, the effort may pay off. For example, the mobility adds a component of geolocalization that is currently booming. In fact, it's likely that the next generation of digital cameras will include a GPS module to facilitate this task. An example of metadata based on location usage can be found in Panoramio, a web tool developed for Google Maps. Panoramio enables users and photographers to geolocate and store photographs within Google Earth and Google Maps. Photos can be geo-tagged, based on the location information, and offered to the public in the two Google platforms previously mentioned. In addition, the Open Geospatial Consortium (OGC) implemented Open GIS, which is currently used by ACIS to store in it database information about monuments and sites and its geographical information [22].

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