SERIOUS GAMES AND E-LEARNING-LEARNING STANDARDS: TOWARDS AN INTEGRATED EXPERIENCE

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***Abstract**: Since the emergence of e-Learning-Learning systems, researchers have explored methods to increase their efficacy, and support a wider range of pedagogical approaches. Similarly, the concept of using Game Based Learning, taken commonly to refer to the use of digital games for education, has also been the subject of a substantial volume of research into their pedagogical design and impact. The popularisation of Game Based Learning has occurred in parallel with the establishment of E-Learning systems; however, questions remain on both technical and pedagogical levels as to how games can effectively be integrated into e-Learning systems. Games can differ substantially from other educational media when used as learning resources, as they may combine high-fidelity audio and video content and employ experiential, social, or exploratory pedagogies. Observing that games are not commonly designed to be included in E-Learning-Learning systems, and that most E-Learning-Learning standards at present do not specifically include affordances for Game Based Learning, this paper explores recent advances in standardisation of Game Based Learning descriptions, and their integration with ELearning- Learning standards.*

***Keywords:** Standards; e-Learning-Learning; Serious Games; EduGameLab; Metadata.*

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I. Introduction

As games are increasingly being recognized for their educational potential, the question of how they can be incorporated into teaching practices becomes more prominent. Games with such potential are commonly classified under the umbrella term *Serious Games*, which includes different types of educational games, and is often used to refer to both games and experiential environments for learning [1], [2]. Simultaneously, the use of e-Learning systems, such as virtual learning environments (e.g. Sakai[3], WebCT [4], Moodle [5]) is becoming an accepted practice. More recently MOOCS (Massive Open Online Courses) [6], have permeated formal as well as informal learning as means of distributing course materials to extremely large numbers of learners across the Web. In essence a MOOC is a type of online course aimed at large-scale participation and open access via the Web which reflects the open education paradigm suggested from the proliferation of open educational resources. This "massive adaptation of e-Learning" [7] has led to a variety of learning standards that support these e-Learning systems in various ways. Computer games on the other hand are quite different to other educational media: they often combine high-fidelity audio and video content with experiential, social, or exploratory pedagogy and also often incorporate multiple learning objectives.

They are also difficult to decompose into constituent parts or individual learning objects without losing the traits of a playable and engaging game. This makes it difficult to describe games as self contained learning objects [8]. This makes sharing educational games via learning object repositories difficult. Most standards allow linking to games, but do not allow for a deeper integration in which pedagogically-salient information is transferred between the game and e-Learning systems.

Consequently, they treat games similarly to static objects such as videos, and do not take advantage of any information that is collected through game play, whilst the game itself is unable to take into account any dynamic information coming from the e-Learning system. This paper introduces relevant e-Learning standards (Section II) and description schemas for Serious Games (Section III). We then outline recent advances towards effectively describing Serious Games in a way that can be integrated in learning standards, in (Section IV), as well as sharing experiences with such games. We also highlight (Section V) advances on achieving a deeper integration with learning systems, and the implications this has for future standards. Our conclusions (section **Error! Reference source not found.**) focus upon identifying the most important open questions to be resolved.

II. E-Learning Standards

Metadata is essentially “data about data”, used to describe an information source. A catalogue or index, in which each information source is represented as a metadata description detailing key features such as author, title, publisher, subject, etc., can be searched rapidly and remotely, for example in repositories accessible via the web. A number of metadata standards have been developed, notably in the traditional library world, which offer standard ways to create such descriptions – for example, cataloguing codes such as the Anglo-American Cataloguing Rules (AACR) [9], the newer Resource Description and Access (RDA) [10], authoritative lists of subject headings such as the Medical Subject Headings (MeSH) [11] and the Library of Congress Subject Headings (LCSH) [12], and classification schemes such as the Dewey Decimal Classification (DDC) [13], the Library of Congress Classification (LCC) [14] and the Universal Decimal Classification (UDC) [15]. Many specialist classifications and thesauri have also been created, which offer a degree of vocabulary control and support for concept searching within particular subject domains.

In the web environment, other metadata standards have been developed. Dublin Core [16] is a relatively simple metadata scheme being used increasingly by the authors of Web documents. It can be thought of as a cut-down and simplified form of catalogue code such as AACR, in that it specifies how to describe a document’s structural elements in terms of 15 main elements: *coverage*, *creator*, *format*, *date*, *description*, *identifier*, *language*, *publisher*, *relation*, *rights*, *source*, *subject*, *title* and *type*. External pre-existing metadata standards and subject classifications such as the Dewey Decimal Classification (DCC) and Medical Subject Headings (MeSH)) may be referenced within Dublin Core via Qualified Dublin Core which adds qualifiers to the Dublin Core Metadata Element Set. Furthermore DC-ed [17] is an application profile of Dublin Core. It is intended as a plug-in for the educational domain. It is designed to support resource discovery, educational use of resources, to be extensible and jurisdiction neutral.

A number of metadata and related standards have been developed specifically for the field of education. These are designed to enable learning resources and designs to be described in a standard way to facilitate their discovery, use and repurposing. Standards exist for describing learning resources, learning designs (including the sequencing of learning activities), assessments, and how components of learning designs (including resources an activities) should be packaged in order to enable them to be imported into learning management systems (LMS). Standards thus enable interoperability whereby learning resources and designs can be used in a range of LMS that adhere to them. Notable standards include the IEEE Learning Object Metadata (IEEE LOM [18]) which is primarily designed for sharing learning content as reusable independent units. This is difficult to achieve with games, since they often require a certain technological platform (operating systems, players etc.) and often contain multiple learning objectives. It is difficult or even impossible to deconstruct a game without creating un-engaging or unusable games.

Another important standard is the Sharable Content Object Reference Model (ADL-SCORM) [19]. This standard provides a reference model for web-based e-Learning. It packages content into portable packages, and uses an advanced sequencing specification, allowing for personalization to users whilst specifying communication between client side and the runtime environment. It is often delivered through learning management systems. In recent years games engines such as Unity 3D [20], [21] are starting to incorporate features for supporting SCORM. A potential future development in this area would be an implementation of a SCORM engine that can play both hypermedia and game engine content.

IMS Learning Design [22] is a standard with similarities to SCORM. It uses a similar packaging specification, though emphasis is placed upon activities rather than content. It has advanced features for adaptivity and personalization [23] and attempts at integrating games have been made [24]. However, the integration of games developed in popular game engines such as Unity 3D remains difficult. The IMS Simple Sequencing (IMS SS) [25] and Learning Design (IMS LD) [22] are educational modelling language developed to enable learning designers to describe in a standard way their design of learning activities. IMS SS enables designers to describe the sequence in which learning activities should be ordered. IMS LD operates at a more complex level, having been developed to enable the description of learning designs not limited to the limited sequences specifiable in IMS SS.

The concepts and relationships specified by IMS LD allow learning designers to model activities by which learning objectives may be achieved. It does this at a sufficiently generic level to enable the modelling of learning designs, which use a range of pedagogical models, for example, case study, inquiry-based, competency-based learning, and so forth, based on a variety of pedagogical perspectives (behaviourist, cognitive, social constructivist, etc.). Since it allows designers to model different pedagogical models, IMS LD is often described as a pedagogical meta-model. IMS LD uses a “theatre” analogy in that learning designs are described in terms of plays consisting of series of acts, entailing actors playing different roles, engaging in activities, within an environment offering services (for example, chat rooms, bulletin boards, presentational facilities, etc.) and learning objects providing content. Learning designs are geared to the achievement of learning objectives, and may entail the specification of prerequisites. To the extent that it is independent of specific content, a learning design may be reused with different content. Conversely, different learning designs may be applied to the same content.

Other popular standards such as IMS Content Packaging (CP) [26] and Question and Test Interoperability (QTI) [27] focus mainly on hypermedia content, and do not support games beyond linking to them, treating games as static pieces of content similar to videos as previously described.

III. Models and Frameworks for Describing Serious Games

Several frameworks for Serious Games have been proposed. One such framework is the Four Dimensional Framework (4DF) [28]. Whilst designed for the evaluation of games, it has also influenced the development process for several Serious Games, as well as the development of the metadata schema for describing Serious Games described in Section IV. The 4DF consists of four "dimensions" as follows:

- Learning Specifics: the profile, role and competences of the learner
- Pedagogy: e.g. associative, cognitive, social / situative
- Representation: the fidelity, interactivity and level of immersion
- Context: The environment, access to learning, supporting resources and topic being studied.

Another framework is the Relevance, Embedding, Transfer, Adaption, Immersion and Naturalisation (RETAIN) Model [29] that can be used to assess how well educational games contain and incorporate academic content based on four existing learning theories: Keller's Attention, Relevance, Confidence/Challenge, and Satisfaction/Success (ARCS) model [30], Gagne's Events of Instruction [31], Bloom's hierarchical structure for knowledge acquisition [32], and Piaget's ideas on schema.

Another complete methodology is presented in [33] as the EMERGO method. EMERGO provides a methodology and generic toolkit for developing and delivering Serious Games aimed at the education sector. The EMERGO methodology capitalizes on core principles of software design, namely the clinical nature of the design, development, delivery and evaluation lifespan of a software project. EMERGO focuses on the learning cases rather than the software development. EMERGO provides a generic toolkit for the efficient development and delivery of multimedia cases. Through EMERGO cases, learners are engaged in both a rich and challenging learning environment where they encounter realistic problem situations, and constantly are being confronted with the consequences of their acts. A core principle here can be seen to be the emphasis away from a software product and towards an educational product with a software component, reinforcing the supposition that game based learning is often most effective when selectively blended into other educational approaches [34].

Harteveld et al. claim that there is a lack of proper and comprehensive design theories for Serious Games development. Based on an analysis of the development process of a game for trening levee patrollers they propose a design theory that reflects the trade-off between: lay, meaning and reality; which they claim form a unique challenge in Serious Games design. The play dimension represents the world associated with digital games, i.e. elements such as game technologies and graphics; immersion and fun; and specific game elements like rules, challenges, competition and scores. The latter ones are at the core of entertainment games. Meaning and reality refer to issues concerning pedagogy and real world topics. Tensions between the components result in design dilemmas and trilemmas which makes it hard to balance a serious game. Notably, most models describing Serious Games lack a representation of this tension between utility and entertainment even though it is one of the distinguishing characteristics of Serious Games and has to be considered in any pedagogical situation where a game is used [35]. Hence, we claim that the pedagogical context in which a game is used and the purpose of using it is of particular importance in Serious Games. The complexity of designing Serious Games, in particular educational games, is further addressed in the project Scandinavian Game Developers which aims to develop methods to support game designers in producing educational games. In particular, Scandinavian Game Developers is targeting game developers to inform them of the peculiarities of designing Serious Games, as they are getting an increasing number of requests to design such.

Serious Games represents the state-of-the-art in the convergence of electronic gaming technologies with instructional design principles and pedagogies. Their state-of-the-art is identical to the state-of-the-art in Entertainment Games technologies. Serious games can exist in many forms including: mobile applications, simple web-based solutions, more complex ‘mashup’ applications (e.g. combinations of social software applications) or in the shape of ‘grown-up’ computer games, employing modern games technologies to create virtual worlds for interactive experiences that may include socially based interactions, as well as mixed reality games [36]. Despite the value of highfidelity content in engaging learners and providing realistic training environments, building games, which deliver high levels of visual and functional realism, is a complex, time consuming and expensive process. Therefore, commercial game engines, which provide a development environment and resources to more rapidly create high-fidelity virtual worlds, are increasingly used for serious as well as entertainment applications. Towards this intention, a game selection framework was developed for selection of game engines for serious applications and sets out five elements for analysis of engines in order to create a benchmarking approach to validation of game engine selection [37].

A well-known classification system for Serious Games is that of Prensky [16]. This approach focuses on dividing games into categories. This is done based on possible game styles (e.g. role play games, puzzle game), learning activities (e.g. coaching, practice) and content type (e.g. facts, skills). Whilst it may seem not directly related to our aims of integrating Serious Games and E-Learning standards, this classification led to the inclusion of content type and learning activities in our metadata schema as we perceive these to be vital pieces of information for those interested in using and sharing Serious Games.

Pivec and Motetti [38] introduced a learning objectives based classification. This classification uses the features required, typology, and number of players and a set of learning objectives to classify games in the flowing groups. This classification leads us to conclude that the description of learning objectives is an important aspect of describing games especially given that Serious Games often have multiple learning objectives, unlike most other educational material. The classification classifies games along the following main categories:

- Memory/Repetition/Retention (factual knowledge);
- Dexterity/Spread/Precision (sensorial knowledge);
- Applying Concepts/Rules (translating knowledge into new context);
- Decision-making (strategy & problem-solving);
- Social Interaction/values/cultures (understanding the social environment of others);
- The ability to learn/self-assessment (evaluation).

IV. Metadata for Describing Serious Games as Learning Objects

Within the framework of the EduGameLab project, we designed a metadata schema [39] for describing Serious Games. This metadata schema was intended to be used as an extension to IEEE LOM, in order to enable the sharing of Serious Games. The schema contains a number of fields to describe games in terms of technical aspects, learning objectives and intended educational context, i.e. the type of learners (age group & background and context such as whether the game is used in the classroom, a museum, at home etc.). The development of this schema led us to recognize that games are fundamentally different types of learning material when compared to many other objects common to e-Learning (e.g. hypertext, video, audio), since, as described in Section I, they often contain multiple learning objectives and require a certain technical framework (operating system, player etc) to run. Often, when educators re-use learning material others have made, their usage will differ slightly from that intended by the original author. This is especially the case with games which contain multiple learning objectives or are entertainment games repurposed for educational use. This observation led us to acknowledge that it is important to recognize the context (e.g. type of learners, and the setting such as in the classroom) a game was intended for, and the context a game has actually been used within. Thus, we decided to include contextualized review entries into the metadata schema.

We then designed a web-based tool (available at http://edugamelab.hosting.his.se/sgdb/) for sharing experiences with Serious Games. The tool is aimed at parents and teachers and features a contextualized search, allowing them to search for games that have been designed for a certain context or have been successfully deployed in this context.

V. Direct integration of games into E-Learning Systems

Another challenge posed when seeking to integrate a game fully with an e-Learning system is the emergence of mobile environments and devices [40] as well as the introduction of new sensors such as brain computer interfaces [41] and haptic devices [42]. As such devices become increasingly available to both learners and educators, the restrictions and benefits of a mobile computing environment must be carefully considered with relation to the delivery of game-based educational content. In particular, information interchange should seek to minimize the impact of disruptions in network services, and support for multiple platforms is highly desirable, if not mandatory in the majority of use-cases. The EU-funded MASELTOV project (http://www.maseltov.eu) seeks to provide a suite of mobile applications, including practical tools and educational content, for European immigrants. Within this suite of applications, a Serious Game is being developed which seeks to capitalize on entertainment gaming approaches to incentivizing and rewarding the player, whilst also containing pedagogical content providing an experiential and abstract approach to cultural learning.

Developers of other services will be able to "reward" the player in-game with credit points, which can then be used by the player to purchase both cosmetic and functional upgrades for their character. This allows the developers of these services to define their own activities and actions which they wish to incentivize, and in the case of location- or context-aware services, create mixed reality games.

Similarly, the game intends to provide direct links to educational content, allowing the player to transfer seamlessly from game to online learning environment. Again, however, the lack of a ubiquitous standard for information interchange between game and e-Learning system complicates the process, and the benefit of such a standard exemplified by the highly integrative approach taken by MASELTOV.

VI. Conclusions

As we have seen in this paper, games are increasingly recognized for their educational potential and at the same time the use of e-Learning systems has become an established practice with the advent of Massive Open Online Courses delivered through learning management systems such as WebCT and Moodle. We have reviewed the various standards for e-Learning systems, such as ADLSOCRM and IMS-LD and reviewed metadata standards for describing educational content such as IEEE LOM, and Dublin Core. We have also reviewed existing classifications for describing or evaluating Serious Games such as the Four Dimensional Framework, Prensky's classification and Pivec and Motetti's learning objective based classification. We have seen that games however are not very well integrated into e-Learning standards. Their integration is mostly limited to linking treating games similarly to videos and not taking advantage of any information gathered about students.

Games often contain multiple learning objectives and there are technical barriers with regards to integrating games built in a number of different game engines ranging from open source to proprietary and from using web technologies such as flash or HTML5 to using advanced 3d graphics engines for their delivery. We highlighted our metadata schema for describing games better, which takes account of both technical details as well as important contextual information about the target audience of the game and the audience a game has been used with. This schema forms the bases of a tool for sharing experiences with Serious Games, aimed at parents and teachers, which is currently undergoing a trial phase. Finally we have seen how a practical integration can be achieved with games developed in a commercial proprietary games engine using advanced 3d graphics, such as Unity 3D. The direct integration relies on a communication between the game and the e-Learning system via a series of specified messages and a specified protocol for sending these messages. This is a very promising approach but clearly a standardized way of communication needs to be found, in order for this approach to scale well. I.e. for it to be viable to implement in most serious games and in most e- Learning systems, it is important that there is just one standardized way that needs to be implemented, rather than a custom communication mechanism per game and per e-Learning system. Open questions remain with regards to how to achieve an integration standard that is defined enough for game designers and e-Learning system developers to be able to implement without being too prescriptive on either side. Finally we are conducting trials with a tool for sharing experiences of using games, based on our metadata schema, in order to evaluate whether our approach of contextualizing descriptions of use and intended use will improve the usefulness of serious game metadata for parents and teachers.

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