What makes a good Serious Game – conceptual approach towards a metadata format for the description and evaluation of Serious Games.

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Abstract: Serious Games (games 'more than fun') combine game technology and game-based methods and concepts with further technologies and research disciplines such as ICT, digital media, sensor technology, psychology, pedagogy or sports science and apply it for different application domains. Prominent examples represent games for health, persuasive games, advergames or games for education and training. But what makes a good Serious Game?
The paper starts with a basic understanding/definition of Serious Games being elaborated and presented at the Serious Games Conferences 2010 and 2011, followed by an analysis of related work and relevant aspects for the elaboration of a metadata format for the description and evaluation of Serious Games. This includes parameter sets for game studies and rating systems and evaluation criteria for (serious) game awards as well as usability and user experience issues and evaluation frameworks for Serious Games and educational games in particular. Based on the results of the analytic work, chapter three introduces a rough concept for an extensible metadata format for Serious Games (MDF-SG), offering a 'core' level with essential information about a serious game and a comprehensive MDF-SG Level 2, which might serve as basis for the evaluation of Serious Games. Further, MDF-SG foresees the concept of application 'profiles' for dedicated Serious Games application fields. Finally, a conclusion summarizes the main results and points out further research investigations and aims to encourage an interdisciplinary discussion – also among academia and industry – with regard to a detailed definition of the format ($\rightarrow$ standardisation).

Keywords: Serious Games, metadata format, evaluation, rating, exergames, educational games.

1. Introduction

Recently, Serious Games became very popular, not only as application field for academia, but also as relevant economic factor for the game industry and various business domains beyond entertainment. Examples include educational games and game-based training and simulation environments as well as games for sports and health, marketing and advergames or persuasive and social impact games. Hereby, our understanding of Serious Games is the following: All Serious Games are games, i.e. analogue to any other (pure entertainment) games Serious Games contain gameplay, goals and rules and use game technology. These elements are combined with further domain-relevant methods, concepts and technologies, e.g. pedagogic and didactic concepts for educational games or sensor technology for exergames and are applied within a broad range of serious game application fields.
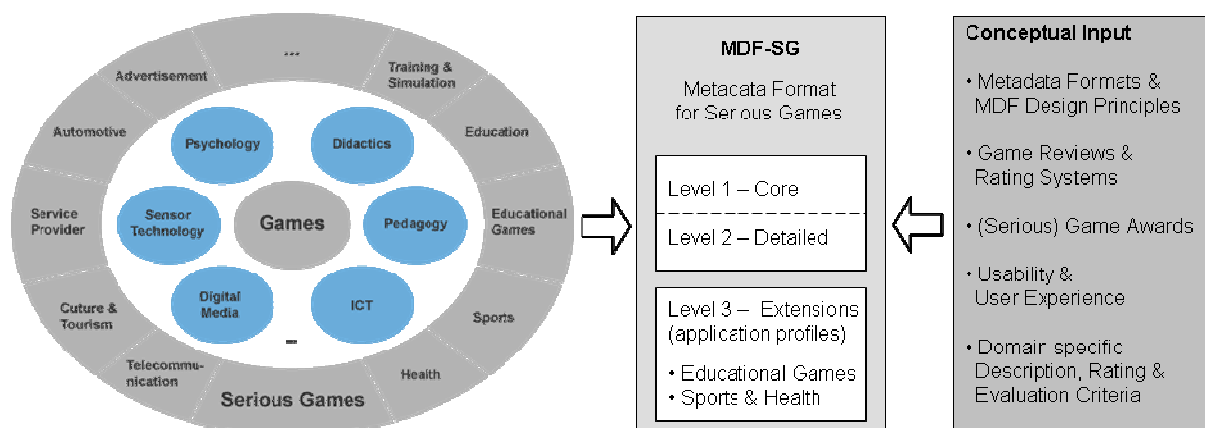

Fig. 1: Understanding of Serious Games (Göbel, 2010) and approach towards a MDF-SG (right).

With the increasing number and broader dissemination of Serious Games, the demand for clearly defined descriptions and appropriate concepts to identify good Serious Games increases as well. For instance, teachers and parents are trying to identify good educational games for school classes or individual pupils, decision makers in industry ask for the monetary and intellectual benefits of Serious Games before the establishment within training programs or doctors, therapists and end-users need arguments to convince health insurance companies to support and finally 'to accept' (= to re-finance)

game-based training programs for prevention or rehabilitation. For that, the idea is to initiate the elaboration and continuous enhancement (→ standardization) of an extensible metadata format for Serious Games (MDF-SG) serving both as description format and evaluation criteria catalogue for the evaluation of Serious Games.

2. Related Work

The basis for the conceptualisation of MDF-SG is built by well-known, proven metadata concepts originated within the library domain (standardised formats and profiles for the description, search and retrieval of books, articles, papers etc. via distributed/federated catalogue systems, see (bib1, 1995) and (Dublin Core, 2011)) and successfully adopted for other application fields such as metadata information systems for geospatial data (Göbel and Jasnoch, 2001; ISO 19115, 2006). Further, mechanisms and evaluation criteria applied for game reviews and rating systems, (serious) game awards as well as user experience and application-specific aspects such as quality labels for educational games are considered.

2.1 Game Reviews and Rating Systems

Well-prepared game studies of the latest titles represent a constant part and selling point of game magazines. The principle aim of the reviews is to provide users (= potential customers) relevant info needed to determine if a game is worth to investigate or not. Hereby, the underlying methods and concepts differ both in terms of the rating process and the rating granularity.

The main difference in the rating process covers the number and expertise of involved game reviewers (editors, independent experts, users/gamers, etc.) and the complexity of testing processes (duration, number and characteristics/performance of testing platforms): Whereas IGN entertainment (IGN, 2011), COMPUTER BILD SPIELE (2011) and GameStar (2011) primarily rely on the expertise and opinions of their in-house editors, the meta review system metacritic (2011) does not only summarize the scores of different connected review systems, but also considers the ratings of users. Typically, the game reviews provide different rating scales for the common game platforms (PC, consoles and handhelds). Exemplary, the testlab of CBS contains 25 computers with different levels of performance (processors, graphic and sound cards) for testing PC games.

With respect to the rating granularity, CBS offers very detailed, platform dependent criteria catalogues. For instance, for PC titles the list of evaluation criteria contains the following categories and weighting factors:

- Pleasure 50% (fascination including gameplay, long-term motivation or AI 20%, graphics 10%, sound 5%, game entrance 5%, usability 4%, game variations 4%, texts 2%)
- Functioning 20% (tests for different processors, graphic cards 15% and sound 5%)
- Options 14% (key mapping 5%, level 3%, resolution 2%, sound 2%, sound standards 2%)
- Others 6% (game status savings 3%, language 3%)
- Installation 5% (installation effort 2%, required storage 1%, delete function 1%, manual 1%)
- Service 3% (hotline technique 1%, hotline game 1%, online help 1%)
- Printed manual 2%

Based on the ratings for the different criteria, an overall score and cost-benefit-index are determined in addition to a short summary and particular strengths and weaknesses of a title. The purpose of the cost-benefit-index is to indicate that cheap games are not necessarily bad and expensive titles do not automatically provide a good quality.

The rating system of IGN provides categories for 'Presentation', 'Graphics', 'Sound', 'Gameplay' and 'Lasting Approval' with a maximum score of 10 points for each category. The GameStar evaluation catalogue provides ten categories (also 10 points max score per category) for 'Graphics', 'Sound', 'Balance', 'Atmosphere', 'usability', 'complexity', Level Design', 'AI', 'Weapons and Extras' and 'Story'. Metacritic does not provide dedicated criteria, but focuses on a summary score (as result of harvesting information from a number of considered rating systems around Europe) and some generic metadata such as the name of the developer studio of a title, the game genre(s) or an age rating label. The score granularity typically bases on 0.5 or 1.0 point steps, whereby IGN states that they originally used 0.1 pts steps, but that didn't make sense – users are more interested in a rough estimation about a title and comparative studies to other similar titles.

Concerning content-related issues in games and the protection of children, PEGI (2011) has been launched in 2003 and is supported by the European Commission. Meanwhile, more than 30 countries in Europe (among others UK, France and Scandinavian countries) apply the PEGI 'de facto standard' in order to attribute games with the PEGI labels '3', '7', '12', '16' and '18' respectively 'PEGI OK' as label for small games indicating that a game can comfortably be played by players of all age groups because it does not contain any potentially unsuitable game content, i.e. violence, sex, bad language

or the promotion of drugs and alcohol. Hence, the PEGI rating system is particularly useful for the decision of educators/parents to invest into an educational game as 'learning tool'.

2.2 Game Awards

Similar to game reviews, different awards have been introduced in order to identify and reward really good (serious) games. Again, concrete, measurable evaluation criteria are missing and only a few awards offer insight into the evaluation process for electing and awarding dedicated games. This situation might be summarised by a statement from IGN concerning the determination of scores:

> *'Unfortunately, there's no science behind a score, no algorithm that can be run to 'get it right.'*
> *It evolves as a process from an editor playing through a game, talking with others about the*
> *experience, and looking at how it stacks up against other games.'* (IGN, 2011)

Hence, typically there are strong discussions among game reviewers or jury members of an award. This discussion is boosted due to the fact, that games and especially serious games are multi-faceted covering a broad range of research disciplines and 'academic cultures', ranging from IT-related perspectives (graphics, sound, interfaces and controls, gameplay and AI, performance issues, etc.) over design-driven approaches (aesthetics, information and communication design) up to cultural, socio-economic (economy, implications and benefit for the society) or humanities-related viewpoints (social science, psychology, pedagogy, sports, etc.). Subsequently – for instance in the context of the Serious Games Award (SGA, 2011) – discussions among the jury members do not only cover scoring issues of particular evaluation criteria, but also fundamental debates about weighting factors: 'What is most important and most valuable – is it an innovative game (design) concept and gameplay, an exiting story, innovative interfaces or the adequate integration and (proven) benefit of the greater serious game purpose?'

The Serious Games Award has been initiated by Hessen-IT as central information and communication platform for IT in the State of Hesse in Germany in 2007. The award originally provided three prices: An innovation price for the best serious game concept, a quality price for the best implemented serious game and a special price for the best serious game K12 (appropriate for kids up to 12 years). The evaluation criteria cover the 'game idea and story', 'technical implementation and usability', 'graphics and simulation character', 'use of the game' and 'entertainment value (immersion, engagement)'. Since 2009, the Serious Games Award is awarded by nordmedia (media association for Lower Saxony and the State of Bremen) in cooperation with the German association for interactive entertainment industry (short: BIU) and the State of Hesse/Hessen-IT. The price money has been increased from 24.000 EUR to 35.000 EUR and is used to award three serious game titles (gold, silver, bronze). The award ceremony is part of the annual Serious Games Conference and takes place in Hannover in the context of the CeBIT trade fair.

The European Innovative Games Award (2011) also provides prices in three categories: 'Innovative Technology' (hardware and software) with the assessment criteria innovative interfaces, new platforms or new application possibilities, 'Innovative Game Design' awarding new forms of gameplay and game design or innovative applications and 'Innovative Application Methods and Environments' covering innovative forms of added value and applications or an innovative scope of application through current existent models. The EIGA award is endowed with 30.000 EUR in total.

The German computer game award 'Deutscher Computerspielpreis' (2011) being established in 2009 by the game associations BIU (primarily publishers) and G.A.M.E. (equivalent for game developers) in cooperation with the German government (ministery for culture and media) is the highest priced award (at least in Germany) with an amount of 385.000 EUR price money in total: 75.000 EUR for the category 'best game for kids (K12)' – typically a simulation, adventure, racing, quiz/braingame or jump ´n´ run – 75.000 EUR for the 'best youth game (K12-K16)' – e.g. sport, action-adventure, role-playing game, strategy game or a genre mix – 50.000 EUR each for the best browser game, best mobile game and best Serious Game – e.g. educational games or games for training and simulation – plus 35.000 EUR for a best (non-professional) 'newcomer concept' (submitted by students or pupils) and another 50.000 EUR for the overall best German game (one of the winners of the different categories). Both DCP and EIGA are not explicitly dedicated for Serious Games, but the list of the latest nominees and winners point out the great (innovation) potential of those games with a higher purpose than pure entertainment. Corresponding to the lack of detailed evaluation and assessment criteria, the letters of entry for the game awards are also very vague and do only provide a free-text field (1000-2000 characters) for a brief description of the product illustrating its innovative nature, apart from generic information such as the point of contact or country and date of manufacture.

2.3 Usability & User Experience

Soft factors such as fun, motivation, emotion, immersion or flow represent key elements of games and typically decide about success or failure of a title. Therefore, recently a lot of research effort has been investigated into the analysis of those aspects including the conceptualisation of user experience assessment criteria. Based on the usability standards ISO 9241-10/-11, ISO 14915-1 and ISO 13407 and user experience research by Mandryk et al. (2006) and Nacke (2009, 2010), TU Darmstadt has been elaborated a questionnaire for the evaluation of Serious Games in an interdisciplinary study between the Multimedia Communications Lab and the faculty for psychology (Gutjahr, 2010). Hereby, the main idea is to create a simple tool (in form of a questionnaire) in order to measure the (individual) user experience of a gamer in addition to relevant usability aspects (software: interfaces). Further, individual feedback concerning possible game design improvements should be collected in order to figure out correlations between game design aspects and the user experience of users/gamers. The questionnaire is structured into two main parts: A user (experience) part with seven categories and a game (design) part with ten categories (see figure 2). For each category, three questions are provided within the questionnaire resulting in a total amount of 51 questions. Each question has an evaluation scale between 1 and 10 points, average scores are built per category and for the two main parts and an overall score. A first evaluation study with 16 participants (age M=23.7 (SD=2.4); 2 woman) playing the two games Winterfest (2011) and Re-Mission (Kato, 2008) has shown a high consistence ($\alpha < .94$) of the total user experience value. This implies that the user experience scale of the questionnaire measures **one** homogeneous construct. Hereby, the total user experience value shows how much a gamer likes a game and might be used as measurable factor to compare the user experience among different games. The subscales of the game design part of the questionnaire indicate how gamers estimate/evaluate the quality of game design aspects (e.g. cornerning the gameplay or story).

2.4 Serious Games for Education, Sports and Health

Serious Games always have an overall aim, for instance the dissemination of a socio-cultural relevant topic (energy, climate, security, etc.) or the support of learning and training processes. A lot of research has been investigated to show effects and to prove the benefit of Serious Games in particular application domains. Examples include work from Malone and Lepper (1987), Klappers (2003), Mitchell and Savill-Smith (2004), Egenfeldt-Nielsen (2005), de Freitas and Oliver (2006), Prensky (2007), Law et al. (2008) and Shen, Wang and Ritterfeld (2009) in the field of game-based learning (see also PEGI website, menus 'Facts & Figures – Did you know?' and 'Games and Education') or work from Lieberman (2001), Baranowski et al. (2008), Kato (2008), Papastergiou (2009), Kretschmann (2010) or Whitehead et al. (2010) in the field of games for health and sport. Nevertheless, these approaches neither provide concrete description formats nor evaluation and assessment criteria (metrics) to describe and to measure the 'use' of Serious Games in a quantifiable way. Though, promising approaches in that direction offer the evaluation framework by Connolly, Stansfield and Hainey (2009), the taxonomy for Serious Games by Sawyer and Smith (2008) and the work by Ritterfeld, Cody and Vorderer (2009) about mechanisms and effects of Serious Games as well as recommendations by Haskell et al. (2007) and the world health organisation (WHO, 2010) in the field of physical activity and health as well as – analogous to game studies and game awards – learning awards (e.g. eureleA and Medida) or quality labels for learning products such as the 'TUD Gütesiegel' (Bruder et al., 2004). Here, the idea is to extend educational evaluation schemas with usability and user experience aspects (derived from the games community) covering not only traditional learning products but also game-based learning arrangements.

3. Concept for a Metadata Format for Serious Games

Based on a) the results of the analysis of related work (→ parameter sets), b) well-known metadata principles (→ ISO standards, level concept) and – most relevant – c) the purpose of the MDF-SG for the target user groups (→ user-centred design), a rough concept (Version 0.1) of the MDF-SG has been elaborated. Figure 2 summarises the different approaches (and underlying criteria sets) of the related work and presents the level concept of the MDF-SG: Whereas Level 1 is intended to provide a brief summary of a Serious Game – both enabling potential customers to get an idea about the quality, innovation and use of a game and serving as selling item for game providers – Level 2 provides a comprehensive description of/for Serious Games. Basically, Level 2 is intended for the evaluation of Serious Games serving as instrument for editors or jury members to measure the quality of a game; user ratings might be offered based on Level 1. Hereby, the resulting scores (by the independent experts) for the main categories of the MDF-SG are used to determine an overall score (rating) of a game. In addition to MDF-SG Level 2, well-known game testing procedures, the questionnaire elaborated by M. Gutjahr and domain-specific criteria catalogues such as the criterion catalogue of the TUD quality label for (game based) learning arrangements build the basis for the evaluation (process)

of Serious Games. Level 3 provides domain-specific extensions (→ Application Profiles) with significant information and metadata fields for individual application domains, but not applicable for the broad spectrum of Serious Games application fields in general.
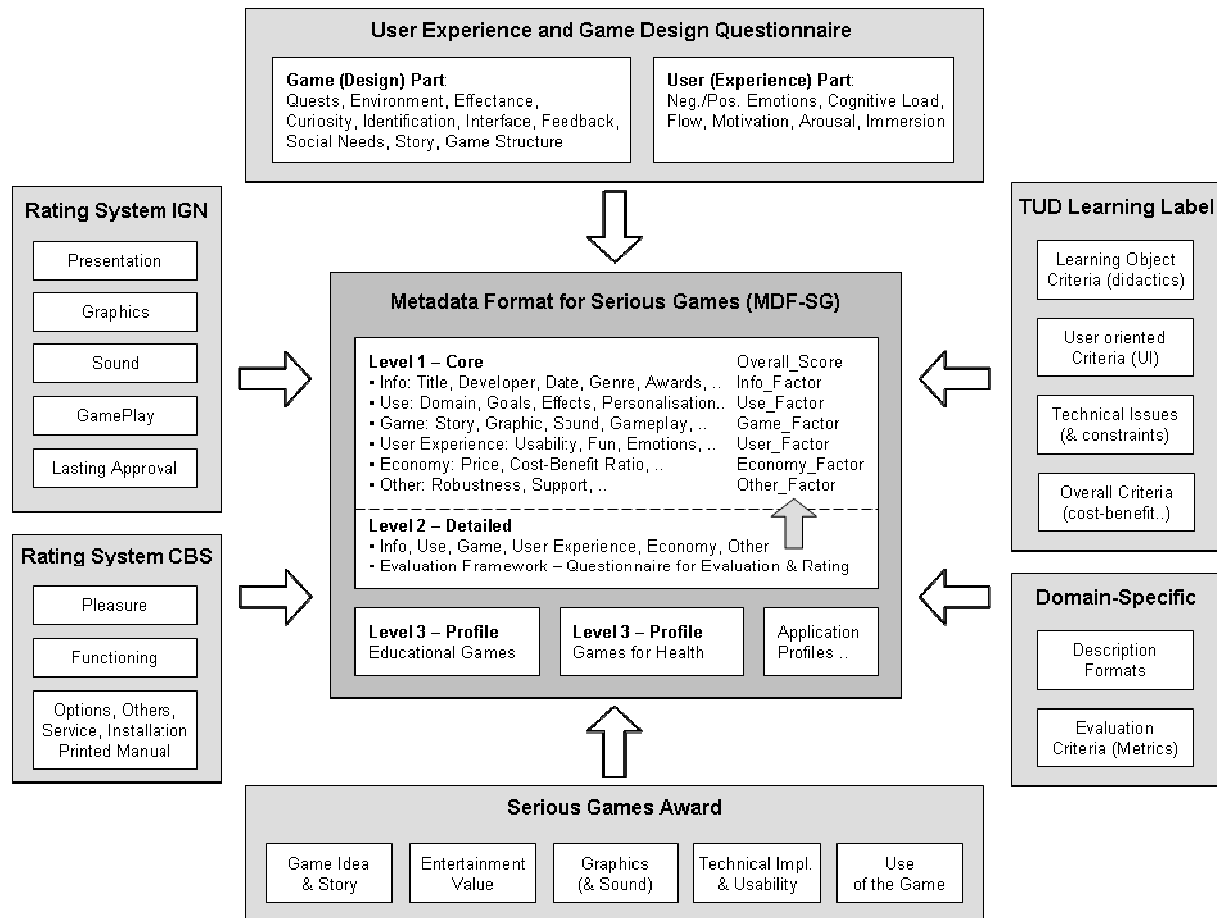

Fig. 2: Conceptualization and structure of the MDF-SG as metadata format for Serious Games.

3.1 MDF-SG Level 2 – Detailed

The MDF-SG is described in an abstract way using a 'Backus Naur form like' syntax: Hereby, in order not to re-event the wheel, at some points existing elements (entities and attribute sets/domain values) from other metadata standards (basically ISO 19115 and its subsets such as CI_Contact for contact information) and game rating systems (for instance content info and domain values for game genres provided by PEGI) are used. Editorial note: All elements are mandatory in principle, optional elements are characterised by '?', '*' and '+' are used for the cardinality of elements (+ indicates that an element appears at least once, * allows that the element is not filled), '//' are used for comments.

```
MDF-SG:           Info Use Game UserExperience Economy Other OVERALL_SCORE
Info:             contentInfo distributionInfo* involvedParty+ metadataInfo?
                  manufacturingDate Recommendation* status? INFO_SCORE
contentInfo:      title abstract Keyword+ preview* PEGI?
                  // preview in form of an URL with snaphot, trailer, ..
distributionInfo: distribChannel distribDescription // with contact info
                  //for online: CI_OnlineResource offline;offline: MD_Medium
involvedParty:    ResponsibleParty PartyRoleCode Contact
                  // contact information based on CI_Contact (ISO 19115)
                  // PartyRoleCode as extensible enumeration list, e.g. Game
                  Developer, Publisher, Producer, Subject Matter Expert ..
metadataInfo:     fileIdentifier language characterSet metadataStandardName
                  metadataStandardVersion
status:           Version ProgressCode // completed, obsolete, ongoing..
Recommendation:   Awards gameStudies userRatings
                  // awards: prices and labels with name, year, quality, URL
```

```
Use:              applicationField+ Purpose Personalisation USE_FACTOR
                  // purpose: scientific evaluation studies proving the benefit
                  of aimed effects
                  // personalisation concepts: options/keymapping, resolution
                  .. adaptive gameplay considering paths, vital parameters..
applicationField: Training and Simulation Game | Educational Game |
                  Game for Health | Sport | Exergame | Advergame | Persuasive
                  Game (extensible list, basis: Göbel, 2010)

Game:             gameIdea Story Graphic Sound Gameplay AI longtermMotivation
                  gameGenre+ GAME_FACTOR
                  // game genre: enumeration list, basis: PEGI, game literature

UserExperience:   Usability Pleasure Motivation positiveEmotions cognitiveLoad
                  negativeEmotions Flow Immersion Arousal, USER_FACTOR
                  // usability: Elements/criteria of ISO 9241, 14915 and 13407
                  // user experience elements (rest): questionnaire by M. Gutjahr

Economy:          priceInformation+ costBenefitRatio? ECONOMY_FACTOR
                  //price Information covers prices for different platforms,
                  business models for maintenance, info about budgets/production

Other:            Platform+ Players Functioning technicalPrerequisites Support
                  OTHER_FACTOR
                  // platform: PC, consoles, online, mobile
                  // players: Single vs Multiplayer, number of players
Functioning:      Robustness gameTests // incl. test platforms, duration, method
Support:          Installation Manual Service // incl. contact information
```

3.2 MDF-SG Level 1 – Core

For the brief description and estimation of serious games, a 'core' set of elements has been extracted:

- Title and OVERALL_SCORE
- General Information: INFO_SCORE and summary of involved parties, recommendations (awards, labels, user ratings), distribution info etc.
- Use: Application field(s), summary about (intended and proved) effects and personalisation and an USE_FACTOR
- Game Synopsis (game idea, story, gameplay, graphic etc.), game genre(s); GAME_FACTOR
- USER_FACTOR and a summary about user-centered usability and user experience aspects
- ECONOMY_FACTOR, price(s) per platform and summary about cost-benefit-ratio
- Other: Summary about system requirements, robustness, level of support; OTHER_FACTOR

3.3 MDF-SG Level 3 – Extensions

Application profiles primarily tackle the 'Use part' part of the MDF-SG. Here, profiles are used to describe domain-specific goals and intended effects on a narrower level. For instance, in the field of educational games, learning object oriented criteria of the TUD quality label are tackled (see figure 2, right part). This covers aspects such as the quality of goals/tasks/quests, content and transfer (evaluation criteria include the transparency of learning goals, the quality of education and the concept of exercises), the quality of personalization (saving of base level, communication and interaction, different presentation forms of content, explanation and requirement level) or the orientation and quality of results (justification/rationale of learning goals, learning controls, help, quality assurance).

In the field of Games for Sports and Health, an application profile might cover aspects such as the description of training programs and particular exercises. For that, the Serious Gaming group at the Multimedia Communications Lab at TU Darmstadt currently elaborates an application profile for a set of personalized exergames using an ergometer and vital sensorics (Göbel et al., 2010). Hereby, the work by Dodge, Metoyer and Gunter (2009) is taken into account. Key elements of the intended profile include information about integrated hardware (ergometer) and sensor technology (ear-clip for heart rate measurement) as well as the intended duration, rhythm and resting (periods), possible modi (speed or RPM) and level (easy, middle, difficult) or the intended average intensity (with upper and lower bounds for heart rates) for the game-based exercises. Effects might be measured in the form of performance parameters such as watt consumption and energy expenditure or in the form of user-centred improvements of the vital status. The latter is not directly quantifiable and, second, shows the importance of personalisation aspects in games, not only in exergames, but also in educational games (with relative, individual and context-sensitive learning effects). Indicators about the quality of training programs and exercises or game-based learning environments/units are provided within the

'involvedParty' section of the MDF-SG (offering citations to training programs and recommendations or links to involved sport and medical scientists).

4. Conclusion

This paper describes substantial work towards the development of a metadata format for Serious Games. Based on a comprehensive analytic work within the complex field of game reviews, rating systems and awards, usability and user experience research and considering (Serious Games) domain-specific approaches, a first rough concept of MDF-SG as modular, extensible metadata format for Serious Games has been introduced. MDF-SG follows well-known principles for metadata formats and offers three levels: A 'core' (Level 1) with rating factors and short summaries is provided for potential customers of a game to get an overview. A comprehensive level (Level 2) provides detailed descriptive information and might serve as supporting tool for editors or jury members of awards to evaluate the games. Application profiles (Level 3) provide domain-specific extensions with further mandatory and optional fields in addition to the elements of Level 1 and 2.

Further research needs to be investigated a) into the identification and integration of metric, quantifiable metadata elements such as (fixed) code lists or (extensible) enumeration lists for domain values of particular metadata elements (e.g. party role codes or game genre), b) into the elaboration of automatic, IT-based evaluation and measurement mechanisms – especially concerning the user experience factors (cf. research results achieved within the EU project FUGA, FP6-NEST-28765, using neurophysiological sensor technology) and c) the elaboration of profound application profiles for the different application fields of Serious Games.

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