Towards a Grid for Characterizing and Evaluating Crisis Management Serious Games: 
A Survey of the Current State of Art

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ABSTRACT

Over the last few decades, interest has grown in the use of serious games (SG) and their assessment in almost every sector. A privileged application domain of SG is crisis management (CM) in which these tools improve crisis behavior and/or management in a safe environment while reducing training costs. However, it is difficult to characterize and evaluate such specific SG. This article proposes a comprehensive grid defining features for description, analysis and evaluation of Crisis Management Serious Games (CMSG). First of all, the authors introduce SG, CM as well as evaluation and assessment concepts, and discuss their particular challenges by highlighting the need of using assessment and evaluation techniques to support learning and/or training. Then, the authors present, classify and compare the most relevant techniques dedicated to address this need by encompassing the state of the art of learners’ assessment and evaluation approaches used in CMSG. Finally, this article presents in detail the proposed grid and discusses the major findings and contributions.

KEYWORDS
Characterization, Crisis Management, Evaluation, Grid, Learners’ Assessment, Serious Games, State of the Art

1. INTRODUCTION

In the last few years, the increasing use of Information and Communication Technologies (ICT) has offered a new horizon for using simulation and gaming as methodological tools for an effective learning/training (Walker et al., 2011). Nowadays, considerable attention has been paid to a new class of games called “Serious Games” (SG) which was created for training or educational purposes rather than pure entertainment (Alvarez, 2007). Thanks to their approach combining seriousness and fun as well as the interesting and useful opportunities they provide (interactivity, immersion, simulation, etc.), they have become very powerful and popular learning devices (Boughzela, 2014). The main

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goal of the SG is to make the knowledge and/or competencies acquisition more effective in a wide range of sectors including defense, communication, education, and health by increasing the learner motivation and engagement while playing.

Crisis Management (CM) is exemplar as an application domain where SG development has grown exponentially and thus has been the object of numerous research studies in serious games area (Di Loreto et al., 2012a). CM popularity resides in exploring different types of crisis (natural disasters, terrorist attacks, nuclear or industrial accidents, etc.) each involving multiple roles (firefighters, medical first responders, police, civil protection, etc.) and collaborative behaviors (evacuation, victim salvation, decision process, etc.) (Daoudi et al., 2017). Serious games for crisis management (CMSG) are considered as a new alternative training approach to teach workers different kinds of skills (technical and/or soft) and to train them to manage emergencies in an engaging way (Di Loreto et al., 2012a).

In the literature, several research works have been proposed to assess and/or evaluate learners-players using various techniques in individual and/or collaborative training contexts of crisis management. They focus on different evaluation criteria such as:

- Learning aspects covering competencies/skills (Oulhaci et al., 2015), and knowledge (Silva et al., 2014; Anita et al., 2015; Mendez et al., 2009);
- Emotional aspects including stress, fear, and panic (Mora and Divitini, 2014; Nguyen et al., 2014);
- Social aspects consisting of coordination (Theo Ovan et al., 2015), cooperation (Di Loreto and Divitini, 2013), and communication (Haferkamp et al., 2011; Di Loreto et al., 2012b).

All these studies show a growing interest to CMSG in improving and supporting both technical and soft skills. This growing interest is followed by an increasing need to identify the characteristics (descriptive features) and the common evaluation criteria (success factors) in order to compare them and to measure their effectiveness for learning. Meeting this need requires specific aspects and principles that can be validated and applied by domain experts and/or evaluators in order to characterize and evaluate the success of serious games environments for crisis management training. Considerable efforts and publications are currently being devoted to researching and evaluating CMSG, thereby increasing both the quantity and the quality of such evaluations (Oulhaci et al., 2015; Haferkamp et al., 2011; Theo Ovan et al., 2015; Carole et al., 2016; Silva et al., 2014; Sooraj et al., 2016; Di Loreto et al., 2012b; Anita et al., 2015; Mendez et al., 2009; Tena-Chollet et al., 2016). Considerable weaknesses remain, however, including the following:

- The absence of comprehensive classification for comparative evaluation techniques used in CMSG.
- The absence of an evaluation analysis grid for characterizing and evaluating CMSG.
- A lack of implicit (“stealth”) techniques for data-gathering and assessment in CMSG.
- A lack of works considering both emotional and social aspects in evaluating collaborative CMSG.

In short, despite a promising increase in methods and findings, we continue to lack a classification of evaluation/assessment techniques used in CMSG as well as an overarching an evaluation analysis grid for describing and evaluating such environments. In this perspective, this article tries to bridge these two main research gaps by building a new classification of evaluation/assessment techniques in CMSG and a new Grid of criteria for Characterizing and Evaluating Crisis Management Serious Games (G-CE-CMSG). The classification aims to present and classify the most existing techniques
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