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# Towards an integration of the multi-role dimension in the design of learning games: a review of the literature.

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**Abstract.** Serious Games (SG) have become popular and their efficiency has been proven in numerous domains throughout the years. You can find them for a plethora of subjects, in bountiful forms and consequently, to answer various needs. They are particularly efficient to reproduce concrete situations and to train on specific objectives. However, most of them are only designed for one player. One explanation might be their design that seems indeed more complex for multiplayer SG. This paper focuses on a certain type of multiplayer SG: those based on multi-role. Thus, this paper aims at drawing a state of the art of multi-role SG and their design, as a first step to propose a design model of multi-role SG.

**Keywords:** Learning Game · Multi-role · Multiplayer · Serious game · TEL Design.

## 1 Introduction

Years ago, serious games emerged, took shape and have been developed ever since, taking various forms and fulfilling countless goals. Their definition can be quite complex so here we are choosing the one stated by Michael and Chen [20]: “games whose first purpose was not mere entertainment.” As technology facilitates their creation for designers, the number of SG is constantly growing as well as their popularity in the world of education. A special approach of SG, role playing, is particularly interesting as Cheng et al. [11] said: “Role playing allows participants to attain knowledge in a different manner and improve their approach to problem solving in a real-world context.” It is thus necessary to define a role, as Warrin et al. did [27]: “in a game, the set of objectives, behaviors, rights, and duties assigned to a person or a group of persons is called a role. A person may play several roles, or inversely, a role may involve several people.”

We could also add the notion of competences, objects, and powers as roles' attributes. Here we are assuming that multi-role games are multi-users, Calandra et al. [10] precised that "Multi-user refers to the possibility, for different users in different places, to play the available roles all together and at the same time in a shared experience." So it is really important to consider this in the scenario, so that nobody stays inactive during the game. Everyone should have his/her proper objectives within the game and should not be completely dependent on the actions of other players. This complicates even more the conception of the game. We know it can be difficult to design SG in solo mode [16, 18], and naturally the same assessment seems established concerning multiplayer games [21]. Therefore, we can suppose that multi-role games are even trickier to conceive. The research question is: how can we design training scenarios that allow several different roles to be implemented simultaneously? To that end, the present paper aims at drawing a state of the art of multi-role SG. To begin with, the method with which the present state of the art was set up will be introduced. Then, we will explain the categorization of the selected papers. That will allow us to analyse the results in order to exhibit some tracks to answer the research question.

## 2 Method

***Selection and source.*** The papers selected for this state of the art are dealing with multi-role serious games or their design. The goal was to find out if some papers concerning the design of multi-role SG already exist. This research was focused on the websites of those editors and academic research databases: ScienceDirect, IEEE, ACM, Scopus, Web of Science and Springer Link. The keywords used on their search engines were: "multi-role" (with and without hyphen) AND "game" and no restriction of date. Here are the results that led to the remaining papers in the first part of Table 1.

*Science Direct:* the access was given via institution and the papers selected are open access and full text access. Only one result was found with the keywords "multirole game" in the title, the abstract or the keywords. No result was found with the keywords "'multi-role' game". The quotation marks were necessary to avoid all the other words beginning with 'multi-'.

*IEEE:* (access via institution) Four results were found. Yet, even if the words "multi-role" and "games" were present in the abstract, two papers didn't deal with a game or its conception, so they were deleted from the selection.

*Scopus:* (access via institution) the search was based within the title, the abstract or the keywords. The search with open access only resulted in five papers. But as before, three papers had no link with multi-role games so they are not included in the analysis.

*Web of Science:* the search provided five results in open access (four of them were already found previously).

*ACM:* focused on the title, keywords and abstract. Only one result was available.

*Springer Link:* without the "preview only content" we found four results that were restricted to the articles containing the word "game" within the abstract.

This filter resulted in two papers. Unfortunately, their content was not in relation with the subject of this survey so they were not selected either.

**Classification framework.** In this survey, we are looking for papers presenting a model or a tool to create multi-role SG. The aim is to find a generic model or tool, if possible, easily understandable by non IT-professionals. Thus, the papers will be sorted in three categories: 1) the theme (to see if it is restricted to a sector or if it is generic), 2) the type (*e.g.* a game, a model or a tool) and 3) the public (to find if it is usable by anyone).

**Table 1.** Categorization of multi-role serious games

Paper	Theme	Type	Target
Agustin et al. [1]	Generic	Conceptual Graph model	IT-professional
Baturin et al. [5]	Situational analysis	Situational modeling	General public
Breitner et Smith [8]	IT	Software	IT students
Calandra et al. [10]	Fire safety	Game	General public
Cheng et al. [11]	Water	Game	General public
Li et al. [15]	Doudizhu (Poker like)	Card-playing framework	CNN Specialists
Warin et al. [27]	Information System Project	Game	Students
Argenton et al. [2]	Gliding	Game	General public
Arif et al. [3]	Transactions activities	Game	General public
Babu et al. [4]	Post disaster management	Game	General public
Bierre [6]	Game design	Game	Students
Burton [9]	Irrigation	Game	Professionals
Lee et al. [14]	Manufacturing industry consultancy	Game	Students
Schrier [22]	21st century skills	Game	Students
Schulz et al. [23]	Health and care	Game	Professionals
Sequeira et al. [24]	Environment	AI	General Public
Stroe et al. [25]	Fire-safety	Game	Students

As this search led to few papers, it was extended to multiplayer SG in those same scientific research tools. Indeed, the results on the second part of Table 1 appeared with the keywords: “multiplayer” or “collaborative” or “competitive” or “cooperative” and “serious game” and deal also with multi-role games.

### 3 Analysis

First of all, based on this research, we can see that the term “multi-role” (with or without the hyphen) is not often used in SG. Furthermore, even within multiplayer games, they are scarce. Among the seven initial articles, we can see that only one is generic, but is only usable by IT-professionals. All the other papers are dealing with a specific theme and are not supposed to be adapted for another theme. Concerning the extended search, all the results are games (only one paper presents an AI for a game) but the entire selection is oriented to a particular theme and none is generic. It means that there is a genuine need to define a model, a generic tool or at least to be advised on the creation of multi-role SG. Among these papers, only a few explains how the games were designed, how the

scenarios were thought through, at least not for non IT-professionals. Usually, the games were presented to explain their benefits and their special features but there is no mention of a specific game engine allowing them to create their game. Unity was mentioned in [10], authors affirm that the possibilities are infinite with this game engine, but it is not easy to handle for teachers, instructional designer or non professionals. Furthermore, the aim is not to create a video game, but to structure a game, to be guided during the scenario creation process and to define the paths, objectives and particularities of each role. We can note that multi-role games can be in a physical environment: they are not device-dependent, as several games prove it here [6, 9, 11, 15, 27].

The paper presented by Agustin [1] is the closest to what we are looking for: they propose “a conceptual graph model to represent the concept of gaming” and a “building block of the engine to run and control the game”. Even if it seems flexible and quite generic, it appears to be only usable by IT-professionals.

## 4 Discussion

**Existing tools.** As stated before, we found no paper tackling the generic design of multi-role SG. However, a few approaches are interesting and could meet this need. Apart from the results found, a few tools should be mentioned as they bring interesting aspects to answer our questioning: Marne [17] created a generic tool, *MoPPLiq*, to design game scenarios. *MoPPLiq* has not especially been created for multi-role games, but the method used to conceive a scenario could be adapted to meet this need because it is used to model pedagogical scenarios, with objectives to achieve and conditions to go to different steps. One strategy can be used to reach our goal: we can separate the roles within the same scenario. For instance, Marty [19] used a multiplayer game where the players have the same scenario, but are paced differently in order to avoid that all the students progress simultaneously in the game. Another strategy supporting the same scenario is to offer side quests to the players to regulate the flow [7]. Next, the tool *MAGES* [13], based on the models *SEGAM* [12] and *DISC* [26], could be adjusted for multi-role SG since it is made for multiplayer games. It covers the whole organization part, the pedagogical part and the structure of the game. It would be interesting to adapt it because it has already been made to be generic, so usable in any discipline. Thus, pedagogy can be adapted because the learning objectives can be approached at any moment of the scenario, if they are consistent with the previously defined prerequisites. The tool is structured like a form so it seems easy for non programmers to create a pedagogically coherent scenario. It is also planned to create a database to save several projects on it and to share them.

**To go further.** Another aspect to consider is management of resources in multi-role games. To encourage cooperation, everyone should not access the same elements at the same time. We could go further and define that only one or a few roles can use a specific resource. It would be convenient if the tool could

handle it directly. The question of the persistence of items is also to take into account: do they disappear after a player took them? Definitely or temporarily? All these parameters should be adjustable according to the game objectives. Thus, many criteria are in our sights concerning the design of a multi-role SG authoring tool (*e.g.* pedagogy, distribution of roles, interactions between players, scenarios, genericity etc.).

## 5 Conclusion

To conclude, this state of the art showed that, to our knowledge, there is no model or generic tool created to help designing multi-role SG and usable for non IT-professionals. However, gathering experiences and methods of the papers seen here can give clues to get there. So, creating a model and the reified tool could potentially be very helpful in the process of creating them - in particular for the promotion of cooperative SG which could fit perfectly for multi-role games. In future works, we plan to establish a model based on the relevant concepts seen in this article. This model will lead to the creation of a tool which will eventually enable its users to create games, taking into account the obstacles reviewed in this state of the art. They could be tested in a context of differential learning throughout an asymmetrical gameplay, for instance the reproduction of a scenario between a doctor and a patient or in the civil engineering field, being able to play each actor involved in BIM (Building Information Modeling) process.

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