Literature Review for the Design Methods of Serious Games

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Abstract: This study emphasises the primary designing characteristics of serious games that make a balance between entertainment and education. The method description was utilised as a tool based on the analysis of serious game structure, strategies, model application, and factors of games supporting entertainment and the learning process in the literature. Through Summon system (a systematic digital library that includes various popular digital libraries), 52 potential studies were collected within the recent five years (from 2018 to 2023). The result shows that 13 methods are utilised to design serious games in reviewed papers. These methods involve a diversity of design theories proposed in these papers selected and some potential dimensions that impact the design of serious games to create the balance between entertainment and education.

Keywords: Serious game, Design methods, Educational theories, Dimensions

1. Introduction

Serious games (SG) are designed as particular digital games that not only consider entertainment goals (Rosenthal and Ratan, 2022) but the most facilitate learning (Ávila-Pesántez et al., 2017). Rosenthal and Ratan (2022) indicate that SGs enable more effective promote teaching, motivating, and persuading (Jacobs, 2021) by balancing the serious and the enjoyment nature of the games. In this perspective, many studies (e.g., Czauderna and Guardiola, 2019; Hwang and Helser, 2022; Tsiotras and Xinogalos, 2021) propose various methods to create balance, including incorporating pedagogical elements into gameplay, using appropriate interface technologies, building the context on a solid foundation of knowledge, and supplying simple game mechanics that innately support the game's serious goal without having any negative impacts (Caserman et al., 2020). However, a little study presents a systematic review to conduct the primary designing methodologies that balance learning and enjoyment from SGs. In order to fix the gap, this study aims to analyse SG structure, strategies, model application and factors of games supporting entertainment and the learning process in the literature, finding potential styles of design approaches, theories and related dimensions which create a balance between gaming and learning. This contribution benefits SG designers, developers and educators, as they can integrate educational innovation to address issues that allow generating SGs to be valid (Ávila-Pesántez et al., 2017).

2. Gaming-Based Learning

A large body of research proposed that some digital games were robust tools for teaching and learning (e.g., Loparev et al., 2014; Enochsson et al., 2004; Erickson et al., 2021; Guy et al., 2005) as they can generate indirect and direct advantages in the real world. Even for those who play solely for entertainment, some digital games function better as educational approaches in an informal or formal learning environment that guides gamers to specific objectives. Learning interweaves with enjoyment in such games' design. For example, games can capture and retain players' attention via entertaining mechanisms like storytelling, interactivity, and animations (Ritterfeld and Weber, 2006; Dyck et al., 2003), while efficient learning rules guide players throughout the game's content (Gee, 2006, 2009). Further, the design of digital games affords a new learning experience. Players must be adaptive in order to find different ways to complete a goal by embracing change and using the game's resources wisely (Thomas and Brown, 2011). This adaption means players' abilities are enhanced indirectly. Research shows direct advantages when using digital games in formal learning environments. For instance, such games (i.e., *Civilisation* and the *Sims*) have been combined with conventional classroom exercises to teach students about the evolution of society and its history (Young et al., 2006; McCall, 2016; Squire and Jenkins, 2003).

New designs are emerging with a developmental strategy that aids education, thanks to the successful expansion of digital games. Such 'SGs' are created by integrating educational content within the gameplay (Rosenthal and Ratan, 2022) to be different from entertainment-oriented games with learning-related. SGs have been used as an essential asset in education gradually over decades. Scholars use SGs by involving players in meaning-driven activities and creating scenarios that reflect real-world situations to encourage the formation of transportable knowledge, abilities, and mindsets (Fabricatore et al., 2019). According to Bressler et al. (2021), playing mobile augmented reality games can be beneficial for encouraging serious science learning. Although these studies mentioned SG development and design, many studies have only considered

providing general recommendations related to pedagogical elements (Cano et al., 2016). For the recommendations, there is a limitation in guiding the SG design process (Barbosa et al., 2014), leading to difficulties in generating high-quality educational games (Yusof and Rias,2014). According to Caserman et al. (2020), it is more likely to design useful SGs by balancing the game's serious and playful nature. Hence, this literature review expects to conclude these specific designing characteristics of SGs comprehensively, potential styles of design approaches and theories which create a balance between learning and enjoyment. Because some games have achieved an appropriate serious-game balance to facilitate enjoyment in learning (Rosenthal and Ratan, 2022). For example, Abdul and Felicia (2015) offered a set of guidelines for the conception of learning through play. They integrated game features and elements with a didactic method that benefits the phases established to create an adequate SG (Ávila-Pesántez et al., 2017).

3. Research Questions

The primary design characteristics of games support the development of SGs, which include game theories, game-based learning purposes and functions (Ávila-Pesántez et al., 2017). So, in this context, research questions are carried out, which focus on the aspects considered in the design methodologies. The following explanations clarify some terms in order to avoid ambiguity:

(a). The methodology is about to approach, model, framework, strategies and phases for the design of SGs (Ávila-Pesántez et al., 2017).

(b). The educational theories consider the pedagogical practice of promoting learning (Loughran, 2006) and guide the development of games.

(c). Dimensions related to elements, factors, or features that trigger action and enable an outcome (Zheng et al., 2016).

Based on the explanations of these terms, this research utilises a literature review to concern design methodologies for SGs, involving educational aspects, theories of making games and factors. For this purpose, more precisely, the following concerns are covered in this study:

RQ1. What building methodologies are utilised to create SGs?

RQ2. What educational theories impact a balance between entertainment and education for the design of SGs?

RQ3. What dimensions are used in SGs?

4. Methodology

A systematic digital library *Summon 2.0,* which includes various popular digital libraries (e.g., PsycInFO, Scopus, PubMed and Web of Science), was utilised to collect papers published in the education discipline. The initial selection (433 papers) was from journals and conference proceedings in English between January 2018 and March 2023. The search strategy was carried out based on: ((SG OR educational game OR game-based on learning) AND (design OR methodology OR strategy OR frameworks OR model)). A general review of the title and abstract was implemented to refine the initial selection to get 147 articles. The following rubrics of exclusion were applied to obtain the final selection (52 papers). See Figure 1.

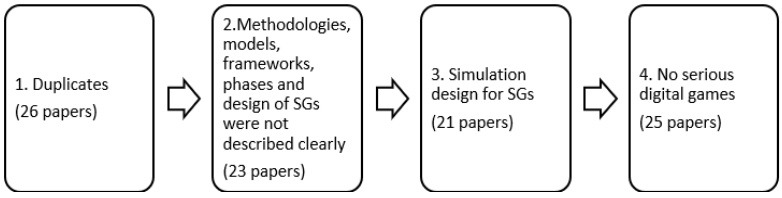

Figure 1: Selection rubrics

5. Result

The findings are shown according to the three RQs, answering the determining methodologies, educational theories, and dimensions for SG design. The related articles are listed as evidence in Figure 2.

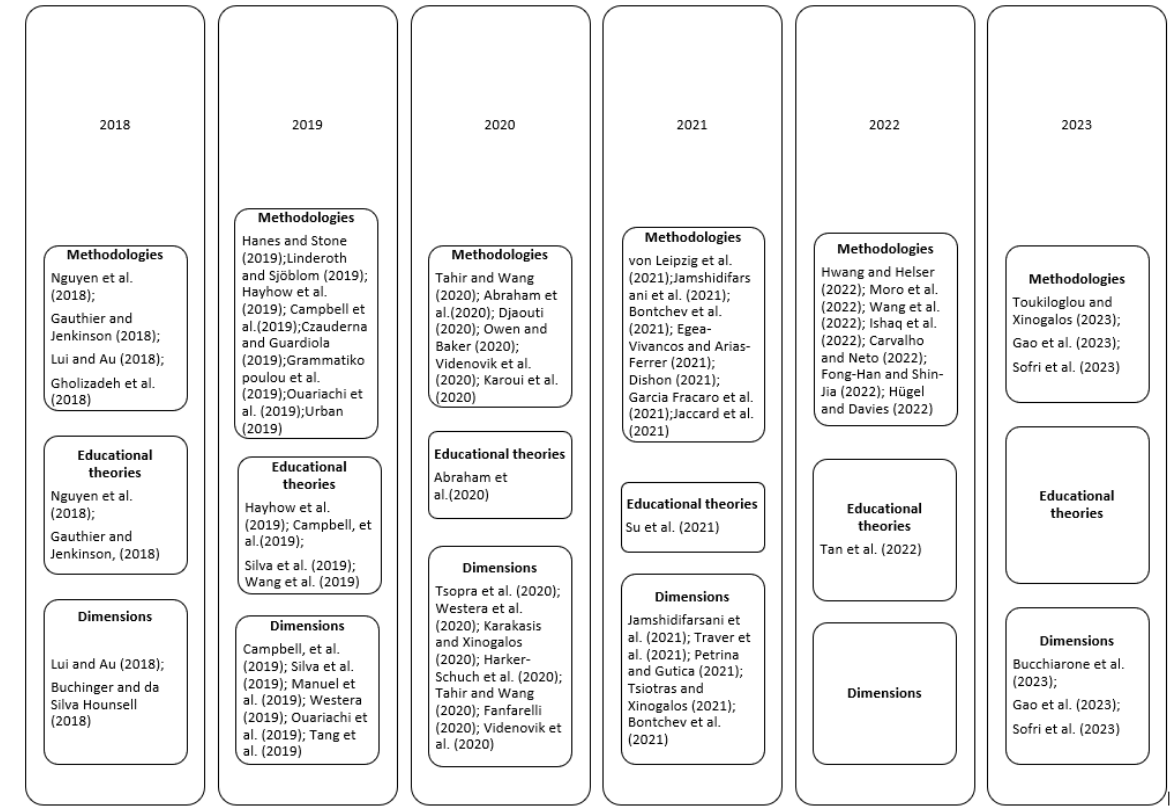

Figure 2: The details about these papers selected

RQ1. What building methodologies are utilised to create SGs?

Thirteen types of methodologies have been utilised to design SGs in 52 papers reviewed. Twenty-seven of these principles (52%) validate their proposals using experimentation processes/case studies. Five approaches (M9-M13) are used only once to design games. These guidelines enable programmers to construct an adaptable and easy-to-use system, which is consistent with Ávila-Pesántez et al. (2017). Most approaches (nine methods) consider specific pedagogical aspects from perspectives of diversity, such as educational goals, learning outcomes and game experience. See Figure 3.

Figure 3: The methodologies used to build SG

RQ2. What educational theories impact a balance between entertainment and education for the design of SGs?

Educational theories are robust underpinnings to support the development of SGs (Jayakanthan, 2002; Pourabdollahian et al., 2012). In order to answer the RQ2, six general educational theories were identified to guide the design of the serious side. The theories explored in these analysed articles included two aspects: didactic strategies (seven papers) and learning principles (four papers), aiming to enhance the learning mechanics, improving abilities and developing player's skills (Figure 4). The two aspects both support the construction of the serious side of SGs. The didactic strategies refer to the way of problem contextualization, and it outlines the goals to be met with the game's design in a situation that accommodates the requirements of the students (Cano et al., 2016). While there are conceptual frameworks for learning that explain and forecast how people learn (Schunk, 1996).

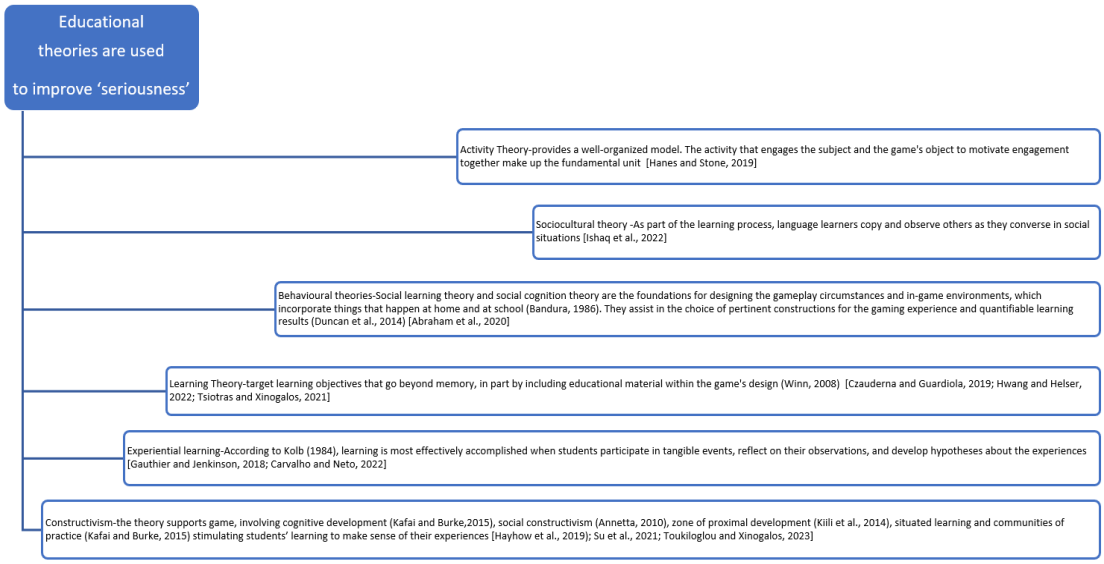

Figure 4: Educational theories used to improve 'seriousness'

Several theories were proposed in selected articles to support the fun of SGs, where students reported much better levels of fun and learnt significantly more than those who learned through traditional means (Fanfarelli, 2020). See Figure 5.

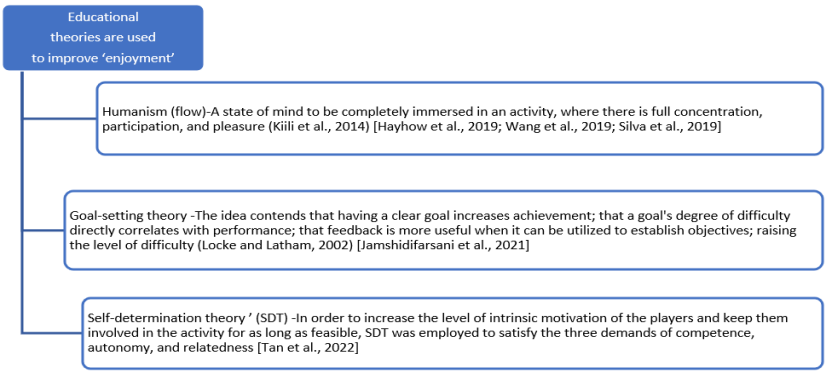

Figure 5: Educational theories used to improve 'enjoyment'

RQ3. What dimensions are used in SGs?

The authors identified 41 dimensions related to the design of SGs (Table 1, 2), which are classified regarding general game features (10 dimensions) (e.g., game story) and development factors (31 dimensions) (e.g., AI). The finding demonstrates that some common traits help create different games (aesthetics care) (Takaoka et al., 2012), and because development methodologies are mentioned in RQ1, some critical factors were extracted from them.

Such elements including the game story, characters, tasks and scenes were frequently mentioned in the general game features analysed. These features can create a relationship of participation among players, so

they are utilised to keep the duration of the game's actions (Ávila-Pesántez et al., 2017). For the development factors, it is visualized that game achievement and dilemma are the most cited in the documents reviewed. If players can complete one of them (i.e., game achievement and dilemma) that is likely to be proved players' abilities, creating a feeling of growth and progress (Ávila-Pesántez et al., 2017).

Table 1: The general game features used in SGs

General game features	References
Game endings	(Gao et al., 2023)
Game tasks/ content design/ Learning activity/ Game goals	(Gao et al., 2023); (Petrina and Gutica, 2021); (Tsiotras and Xinogalos, 2021); (Tahir and Wang, 2020)
Game story/Motivating Storyline/ narrative	(Gao et al., 2023); (Tang et al., 2019); (Fanfarelli, 2020); (Petrina and Gutica, 2021); (Tahir and Wang, 2020)
Game avatar/ Characters/ Avatar with badges/Identity	(Gao et al., 2023); (Manuel et al., 2019); (Tsopra et al., 2020); (Harker-Schuch et al., 2020); (Petrina and Gutica, 2021); (Tahir and Wang, 2020); (Jamshidifarsani et al., 2021)
Game tools/Items/ Game resources	(Gao et al., 2023); (Manuel et al., 2019); (Tahir and Wang, 2020)
Game mode	(Gao et al., 2023)
Non-plater character (NPC)	(Petrina and Gutica, 2021); (Gao et al. 2023);
Hidden Messages and Side Jokes/ Hints/Help	(Tang et al., 2019); (Tsopra et al., 2020); (Jamshidifarsani et al., 2021)
Cutscenes (can introduce linear non-interactive narrative sequences)	(Manuel et al., 2019);
Scenes/Style elements (includes rich audio-scopes and engaging visuals)/ The game design of a particular style (special sound or scenarios)/ variety of activities	(Manuel et al., 2019); (Westera, 2019); (Gao et al. 2023); (Karakasis and Xinogalos, 2020)

Table 2: The development factors used in SGs

Development factors	References
Level/ Progress bar/ Levels of difficulty, metaphors and semiotics	(Bucchiarone et al., 2023); (Tsopra et al., 2020); (Petrina and Gutica, 2021)
Progression	(Bucchiarone et al., 2023)
Point/Reward systems/scores/Achievement	(Bucchiarone et al., 2023); (Westera, 2019); (Tsopra et al., 2020); (Karakasis and Xinogalos, 2020); (Tsiotras and Xinogalos, 2021); (Jamshidifarsani et al., 2021)
Leader board	(Tsopra et al., 2020)
Scaffolding (instruction in text format)	(Karakasis and Xinogalos, 2020)
repeatability (a player masters a task by repeating a set of actions)	(Petrina and Gutica, 2021)
Gameplay	(Tahir and Wang, 2020)
Artificial intelligence (AI) (including personalisation, difficulty balancing, evaluation, player analytics, competence modelling, social gamification, technical considerations and affective computing)/ Technical	(Westera et al., 2020); (Tahir and Wang, 2020)
Dilemma/Challenge provided/Increasing complexity/ Game play	(Tang et al., 2019); (Silva et al., 2019); (Tsopra et al., 2020); (Harker-Schuch et al., 2020); (Lui and Au,

Development factors	**References**
	2018); (Tahir and Wang, 2020); (Jamshidifarsani et al., 2021)
Real-Life Scenarios	(Tang et al., 2019)
Concentration (enable players to be fully absorbed in their tasks)/ Immersion in the real world/ Flow	(Silva et al., 2019); (Tsopra et al., 2020); (Harker-Schuch et al., 2020); (Lui and Au, 2018); (Tahir and Wang, 2020)
Clarity Goals/Intended learning outcomes/ Learning objective	(Silva et al., 2019); (Tsiotras and Xinogalos, 2021); (Tahir and Wang, 2020); (Jamshidifarsani et al., 2021)
Give players feedback/ informed teaching/ Reflection	(Silva et al., 2019); (Tsopra et al., 2020); (Harker-Schuch et al., 2020); (Tsiotras and Xinogalos, 2021); (Jamshidifarsani et al., 2021)
Autonomy to the user (make the players feel in charge of their own actions and performance)	(Silva et al., 2019); (Lui and Au, 2018)
Social Interaction/ Interactivity/Interface	(Silva et al., 2019); (Harker-Schuch et al., 2020); (Lui and Au, 2018); (Tahir and Wang, 2020); (Jamshidifarsani et al., 2021)
Perceived learning (players can do what they need and want)/ The instructional element (the players can play that follows their own pace)/Game attributes/ control/ Learnability	(Silva et al., 2019); (Harker-Schuch et al., 2020); (Tsiotras and Xinogalos, 2021); (Lui and Au, 2018); (Tahir and Wang, 2020)
Gameplay scenarios (give players a way to make sense of the search for causality, space, and time relationships, which helps with game story development)	(Westera, 2019); (Tsiotras and Xinogalos, 2021)
Capability (The games are generated in a way that the players can remember basic knowledge regarding the level that they played)	(Tsiotras and Xinogalos, 2021)
Instructional content (the players learn about different concepts at per level)/ learning content	(Tsiotras and Xinogalos, 2021); (Tahir and Wang, 2020)
Game genre	(Tsiotras and Xinogalos, 2021)
Engagement	(Lui and Au, 2018); (Tahir and Wang, 2020)
Curiosity/Motivations	(Lui and Au, 2018); (Tahir and Wang, 2020)
Fantasy/ Enjoyment	(Lui and Au, 2018); (Tahir and Wang, 2020)
Competition	(Lui and Au, 2018)
Randomness	(Lui and Au, 2018)
Balance	(Lui and Au, 2018)
Learning strategies	(Tahir and Wang, 2020)
Context (the game background where game-based learning will take place)	(Tahir and Wang, 2020)
Game aesthetics	(Tahir and Wang, 2020)
Satisfaction	(Tahir and Wang, 2020)
Cognitive development	(Tahir and Wang, 2020)
Psychology needs	(Tahir and Wang, 2020)

6. Discussion and Conclusion

Based on research questions, the findings showed that the excellent design of SGs trends to new representations and interaction (Ávila-Pesántez et al., 2017) in an educational environment. In order to make a balance between serious and playful, many new approaches were proposed (e.g., M9-M13) to be utilised as a learning aid in several fields of expertise (Susi et al., 2007). Several educational theories were utilised to

highlight the entertainment aspect in order to develop learning competencies while allowing the achievement of skills based on the games. Because players can learn from their mistakes, many studies reviewed present the challenges that strengthen teamwork, collaboration, decision-making competence, and leadership (Cruz-Lara et al., 2013). The established challenges depend on the player's capability and constant feedback. These two dimensions are both reported as important aspects of development factors. Five studies attest that games aligned with learning objectives are the key component of designing SGs. The capability development of players achieved through the SG replies to the clarity of the learning objective, which is likely to promote game tasks, levels, and feedback. Furthermore, when designing SG, perceived learning was taken into account because it allows gamers to decide for themselves using their academic knowledge. The procedure ought to be examined during game creation and integrated with each activity that players undertake to provide feedback.

All in all, this literature review assists in identifying research gaps in methodologies, pedagogical theories and factors that influence the design of SGs. The contributions of this study provide helpful recommendations for creating high-quality SG because it incorporated game dimensions in promoting engagement and supporting learning.

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