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Article

MACMEO: Playable Framework for Analog, Hybrid and Digital Serious Game Design

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Abstract

Practical tools to support newcomers to serious game design are scarce. There is a need to deliver practical, flexible, and analog solutions for educators to use and adapt. We propose the MACMEO framework, developed as a research design process during several sessions (120 minutes on average), a flexible and adaptable gamified analog toolkit to help design analog, hybrid, or digital serious games through a structured process. The framework evolved after being tested with different users, following the design research iterative and experimental process. The updated framework version delivers a toolkit format for faster serious game design sessions, requiring minimal resources but demanding facilitation when dealing with less experienced users. The results show that the MACMEO framework is applicable to define early-stage playable serious game prototypes, filling an existing gap. Users consider it engaging and valuable for learning. During 10 sessions with 78 users, 26 game ideas emerged, including 20 playable prototypes. However, more time was necessary for more development. One-third of them were aiming for digital implementations.

1. Introduction

Serious game design practices tend to follow a similar structure. There is a problem, something to achieve, or a goal, usually unrelated to gaming. Then, a design team develops the game considering this initial purpose, following development processes that are more or less formal, complex, or detailed. The similarities with gamification are evident, but when we aim for serious game solutions, products are closer to standard full-game experiences [1]. Despite these differences, gamification approaches also require concern about the game's overall coherence

with other external and extrinsic motivations. These principles are valid for analog, digital, or hybrid serious game and gamification products [2].

Not learning through established processes/methods is not an issue when game designers are experienced in this field or follow a predefined process from a company. However, when introducing newcomers, students, and professionals from other expertise fields, a fast method is needed to start and organize a game project's ideas, solutions, and goals. More support for learning and practical methods would facilitate dealing with the complexity of developing (serious) games. Teaching approaches like Fullerton's[3] are immensely valuable but go into longer processes. Other seminal works help establish game definitions and concepts [4], [5]. We might say that there is no scarcity of game design books, but few for the purpose of supporting fast processes for educators or novices to start reading and practicing. The existing ones tend to propose longer processes, even those that try to simplify and use analog games to go directly into designing the systems for agnostic platforms [6], [7]. However, all the previous literature does not specifically aim for serious games and the requirements to address other purposes and objectives beyond entertainment.

Our overarching research question is how to develop a fast, playable solution that teaches an introductory design process. This question reinforces a relationship between the need to teach how to design games by delivering tools that users can explore, learn by doing, prototyping, and playtesting. From a practical and technical perspective, we aim to test if providing a framework (with an associated toolkit) that connects mechanics (mechanisms according to the definition applicable to analog games) and components to serious game goals, allowing rapid playtesting, is feasible, especially for newcomers. Explicitly, we address the following sub-questions (RQ):

- Sub-RQ1: Test a visual tool to draft the mechanical/narrative system and establish connections with users' experiences and serious game purposes/goals
- Sub-RQ2: Verify if our tool fits for immediate playtests and improvement of early game ideas.
- Sub-RQ3: Analyze if the same approach (including gamifying elements to engage users and help them learn the basics of a game system) is valid for newcomers and more experienced users (allowing expanding elements).
- Sub-RQ4: Test if the tool allows analog game prototyping for analog, digital, or hybrid serious games.

Despite the absence of clear academic journals and conferences specifically focused on game design, this field is getting increasing contributions in game studies and other related field publications. If, in the past, the role of a game designer might have blurred way as part of other game development tasks, today, game design is a recognized job and a growing topic in literature. The Mechanics, Dynamics, and Aesthetics (MDA) framework [8] is remarkably influential and still dominating, even when criticized and adaptations proposed. MDA limitations are clear (we will detail this in a specific subsection) but still very useful due to its simplicity, flexibility, and ease of support for the first ideas for game design processes.

This paper proposes a light gamified playable process to support the early stages of designing a serious game. The method establishes itself as a framework inspired by MDA but adapted for serious game applications. We propose the MACMEO (Mechanisms, Auxiliary Mechanisms, Components, Experiences, and Objectives) framework, departing from an analog implementation (aiming for analog prototypes) that supports analog, digital, and hybrid game development. The method departed from a first failed experiment and evolved as it was tested by 78 (n=78) participants of different backgrounds and game experience levels over one year. It included students, game enthusiasts, and game teachers/researchers. The method evolved through continuous playtesting and improvement, including participants' feedback and following research design guidelines. We present the overall testing, adaptations, findings, and final solution. MACMEO successfully helped the development of 26 game ideas (20 of those

were viable and playable prototypes) in fast sessions (between 2 to 3 hours on average), including the conceptual and visual model of the game system, identifying game mechanisms (and other game elements), interactions, and relation to serious game goals as the early prototypes in a playable form (including initial playtesting).

The following sections will describe the early motivation and need to develop and improve the MACMEO framework, the design research approach, and the iterative process to make it a practical tool. In the discussion and conclusion, we propose guides and state our proposal's limitations.

2. How to learn how to design games

2.1 From anecdotal perceptions to systematic tools

The author has experience teaching game design and is a game designer himself. Although this is anecdotal and very personal information, it is the reason the research questions emerged. The difficulties were obvious during lectures, classes, and training sessions aimed at teaching newcomers, students, and other professionals to use games, either for entertainment or other applied cases like gamification and serious games. How do you start and avoid the same old game design solutions? Here, we consider game design to be the methodic and creative process of defining the game system, a ludological approach to the mechanical system without ignoring the narratology and narrative game dimensions.

Several authors recommend starting with analog exercises, playing, adapting, and testing our game ideas [3], [6], [7]. However, these long processes would take many hours and sessions to implement. When faster approaches are required, solutions are scarce. Engelstein [9] proposes guidelines for board game prototyping and game development. However, as in previous literature, users must have materials, tools, and considerable experience to develop playable solutions to test, adapt, and improve over several iterations.

We remember several conversations with other game researchers and teachers, one particularly interesting one during the *Foundation of Digital Games 2023* conference (names anonymized). It was an informal conversation, but it revealed the challenges at stake. Our students tended to behave the same way. They proposed the same old type of analog game solutions when their game literacy was low. Individuals unfamiliar with a broad range of game mechanisms may struggle to ideate more novel prototypes and game solutions to address game purposes and objectives. Less experienced students tended to create roll-and-move games, quizzes, or trick-taking card games. As Ethan Ham [7] recognizes, students or newcomers to game design will tend to replicate what they know in their new designs. Some of these previous mass-market mechanisms can deliver misleading game experiences, negative feedback effects associated with luck dependency and a mismatch between the objectives of playing the game for other purposes beyond entertainment [10]. As Lewis Pulsipher [11] recommends, game designers must have a considerable general culture, including game culture, to bring innovation, avoid redundant games, and mobilize the suited mechanisms for the game's goal. Playing many different games is usually one of the first recommendations for starting a career as a game designer [6].

All the previous recommendations help game designers. While building up a game culture and being aware of what to design (purpose and context), newcomers should be more prepared to prototype other game types beyond the classics, mobilizing more adequate game elements for their projects. They can start with analog prototypes, even if the games are hybrid or digital [12]. An analog prototype can easily replicate digital and hybrid games when designers enforce the rules of the mechanical system. After the playable systems are playtested, the prototype can be gradually and partially automated using digital solutions (hybrid) or fully deployed in a digital platform. Using tools such as *Tabletopia* and *Tabletop Simulator* (or others alike) to test

the digitalization and automation of analog systems is a practical and simple solution, especially when designers lack deep coding knowledge of other game engines.

However, to better simulate and mimic reality in these analog prototypes, mastering modern tabletop/analog games is recommended [13], [14]. There is a need to establish a faster method to develop a systemic approach for building these prototypes from scratch.

The lack of time to prepare students is an overall problem that triggered this research. So, we started to develop strategies to test this more systematically, providing tools for students to use new game elements (game mechanisms and other components), and methods for game documentation, connecting the development process to the goals of the games (including games beyond entertainment). For a practical reason, from now on, we will call the students, newcomers and those users who wish to learn game design as students.

2.2 From the literature and established frameworks to a practical solution

Several handbooks propose a reading process and practical exercises to learn about analog game design for analog or digital game creation [6], [7]. Some are very specific for tabletop games. Scott Rogers [15] proposes one of the most simple and graphical readings to follow, while Geoffrey Engelstein [9] goes deep into the production techniques of build and testing a board game prototype. Engelstein and Shalev [16] already launched the second edition of their seminal work, a true encyclopedia of tabletop game mechanisms. Besides these authors and respective publications, many other books aim to teach analog game design. However, there is a gap in the literature for developing serious games or games beyond entertainment that follow a systemic approach. Books like Dörner et al. [17] are valuable but are not handbooks for practical reasons.

Our proposal departs from established frameworks like Mechanics, Dynamics, and Aesthetics (MDA) [8] and its variations like Mechanics, Dynamics, and Experiences (MDE) [18], where designers define game mechanics to deliver meaningful play experiences. These experiences are where the serious side of games and goals can emerge. The MDA is undoubtedly the most cited game design framework (i.e., nearly 5,000 citations at Google Academics), presenting a systematic, simple-to-follow, process. However, its simplification led to several attempts to improve it, detailing it for general games [19] and establishing bridges with serious games [20]. Because we are exploring analog prototyping, we need to adapt the previous frameworks for serious game applications while considering the analog characteristics of our media. The Design, Play, Experience (DPE) framework [21] shows us an example of how more elements like narratives and interfaces play a role in developing a serious learning game. In our case, the goals can be other than learning, but the interfaces are somehow particular. The interfaces are tabletop physical components like cards, boards, dice, pawns, and many different pieces and bits.

The tendency to adopt the term mechanisms as the building blocks of tabletop game design [16] and the granular and smaller elements of the mechanical system of an analog game [22] forces us to adapt our framework. It must represent the combinations of these mechanisms in groups of mechanics from multiple perspectives. Duarte and Battaiola [23] found that the lack of automation in analog games demands a more flexible representation of the effects of the mechanics, dynamics, and experiences. Players can easily change the mechanics (or group of mechanisms) and see how the experiences vary. This flexibility reinforces the claim that building analog games can be transformed into a process to help design all types of games aiming for player-centric approaches. Designers can run the automation necessary for the games to work and even the automation and animated effects that digital games deliver.

However, even if the students have considerable gaming experience, they will need more knowledge to analyze games systematically. Students might know many games and be aware of the overall mechanical system, but identifying all the granular mechanisms and their interconnected effects might be different. Considering that there might exist hundreds of unique

game mechanisms, and it might be challenging to define distinctions between mechanical systems and dynamics [22], the complexity of such a process can be problematic.

Another concern is that we aim to deliver a practical solution. We must test and correct it to achieve our goals (teaching analog serious game design). In a sense, the development of the tool is similar to the process of developing a serious game. We need to test the method, evaluate it, and redesign it [24], [25], [26], [27]. We used a design research method described in the next section to better reach our practical goals.

2.3 MACMEO Framework summary for serious games

As we will explain in detail, the development of the MACMEO framework resulted from a long and iterative process. We present the first conceptual idea in section 3, and the overall continuous improvement is in section 4. It was continuously adapted and transformed into a practical, flexible tool that hopefully can be applied by teachers and trainers in serious game design teaching sessions (Appendix files).

The MACMEO framework (core **M**echanisms, **A**uxiliary mechanisms, physical **C**omponents, **M**etaphors, game **E**xperiences, and purposes/serious **O**bjectives) (Figure 1) is presented in three interconnected dimensions (represented by Roman numerals: I, II and III). Dimension I includes the mechanical and narrative game system (a combination of mechanisms defines the mechanical system integrated with physical components and metaphors). Dimension II relates to the game experiences and emotional player reactions to the game (separated but linked to the game mechanical and narrative system). Dimension III connects the previous experiences to the goals and purposes of the serious game (where all dimensions congregate as game outcomes). The mechanical and narrative system (I) details the core and auxiliary mechanisms, identifying the core actions resulting from the player agency and the other auxiliary mechanisms to control and manage the game system, like data processing, progression, and resolution systems. This way, it can simulate and mimic the automation in digital game systems. The physical components dimension gives tangibility to the framework. It can identify what graphics and game controllers do outside the analog materiality of the game or just set what is needed to play and the emotional reactions when players interact with objects.

The MACMEO aims to expose the mechanical system of games transformed into analog formats (Figure 1-I), including the metaphors (meaning) and how they relate to the game experiences (emotional reactions from players, Figure 1-II) to the serious purposes of goals of the game (serious game goals, Figure 1-III). [17]. There is a clear inspiration in the MDA, but detailing the mechanical dimensions into workable elements (mechanisms). We classify the mechanisms according to their function as part of the mechanical system (core, auxiliary, and the effect of depending on physical components of analog games, represented in Figure 1-I). In order to relate the MDA framework to serious game principles, MACMEO includes an extra step of connecting the experiences to the purposes and serious objectives of the game since that might not exist in entertainment games (Figure 1-III).

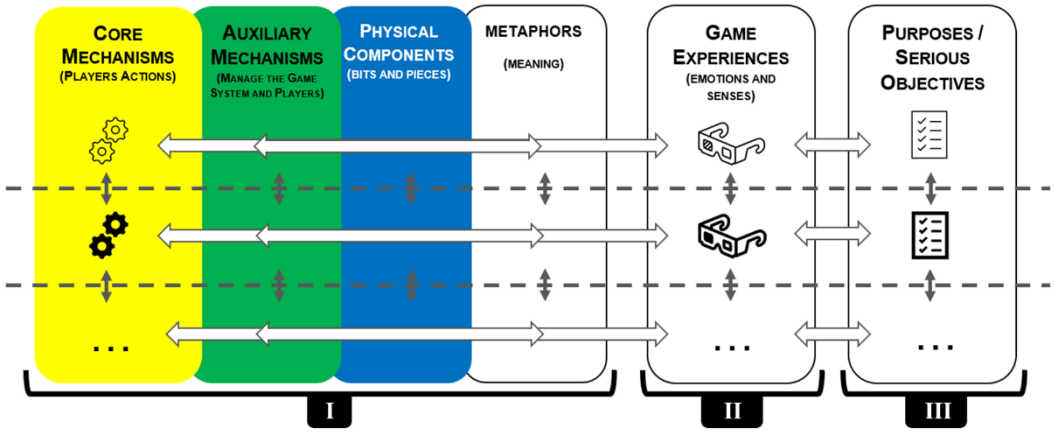

Figure 1. MACMEO framework summary (see detail in section 4). I - Mechanical and narrative game system. II - game experiences. III - serious game purposes/goals

The MACMEO framework (Figure 1) can be easily transformed into a practical canvas that can track the three dimensions (I, II, and III) visually. It avoids the complexity of frameworks like the Design, Dynamics, and Experience (DDE) [19] and proposes a practical way to generate the game documents. Other frameworks propose high-level methods to organize and access the games but are less suitable for use in practical sessions of prototyping and testing game ideas [28]. One considerable difference is that MACMEO applies to any serious game, not just for learning, health, or other applications that have dominated recent literature on serious games [29][30]. From a practical perspective, this agnostic approach is more suited to an introduction to serious games in general. Most of the previous game design frameworks aim for games that lack a connection with the goals and purposes of non-entertainment games, which is the case for serious games. We are not claiming that serious games cannot deliver fun and engaging experiences. They should be engaging, but the ultimate reason why serious games are developed is to reach specific purposes or objectives like learning, training, creating, or achieving other predetermined outcomes [1], [17]. Although serious game purposes and objectives are not agnostic, the MACMEO framework is. Which means it could be applied to any topic or goal.

3. Methods

3.1 Design Research and Case Study approach

As described before, the research questions emerged from the need to support students in learning about game design as a process. The game attempts generated during our classes, training, and workshop activities have continued to deliver insufficient results and were in line with similar concerns expressed in the literature (previously cited). We needed a visual tool to track information about the game system (RQ1), allowing immediate playtesting (RQ2) while engaging students (RQ3) and being able to prototype any game in an analog format (RQ4). Other colleagues we have been discussing with over the last 6 years reinforced this need. Even after taking introductory courses, most students' game prototypes are not in line with state-of-the-art analog game design trends. This limitation means they needed to prepare better for real case design challenges and innovative requirements to deal with serious game goals. We have seen that game design literature recognizes this difficulty. We propose to follow similar approaches to game development ideation, prototyping, playtesting, and correcting[3], [11], [31], which connects to design thinking approaches [32]. We adopted design research

principles [33], [34] to support a trial and error process. Our research questions demanded a practical approach based on playtesting and continuous improvement. The final proposed solution would be very different from the first attempt.

Following Horvath's [35] recommendation for design and engineering, we should start doing empirical and experimental research about our topic and develop new tools and methods, implementing and testing them. Following game design and design thinking practices, repeat the loop of readapting the tools and methods according to the testing results. The results consider the initial research. In other words, this is what case study validity means; we must define our purpose and how we validate it very well [36]. Teegavarapu et al. [34] provide specific guidelines we can use for case studies that support our research design approach (including the playtesting and adapting loops - L):

- (L1) Define & design phase: identify/define problem – build theory – select cases & design data collection protocol.
- (L2) Prepare, collect & Analyze phase: conduct single/multiple case studies – write individual case report.
- (L3) Analyze & conclude phase: Draw-cross case conclusions – compare with rival theories – modify theory if required – write a cross report.

The second and third phases for games happen in loops due to the player-centered design approach [11], [37], where playtesting focuses on direct and indirect player feedback from users' interactions and experience (UI/UX) [31]. Figure 2 presents our method, adapting Teegavarapu et al. [34] guidelines with game design processes and loop cycles. For practical purposes, to track the sessions, playtesting, and adaptations, we will transform it into table (1).

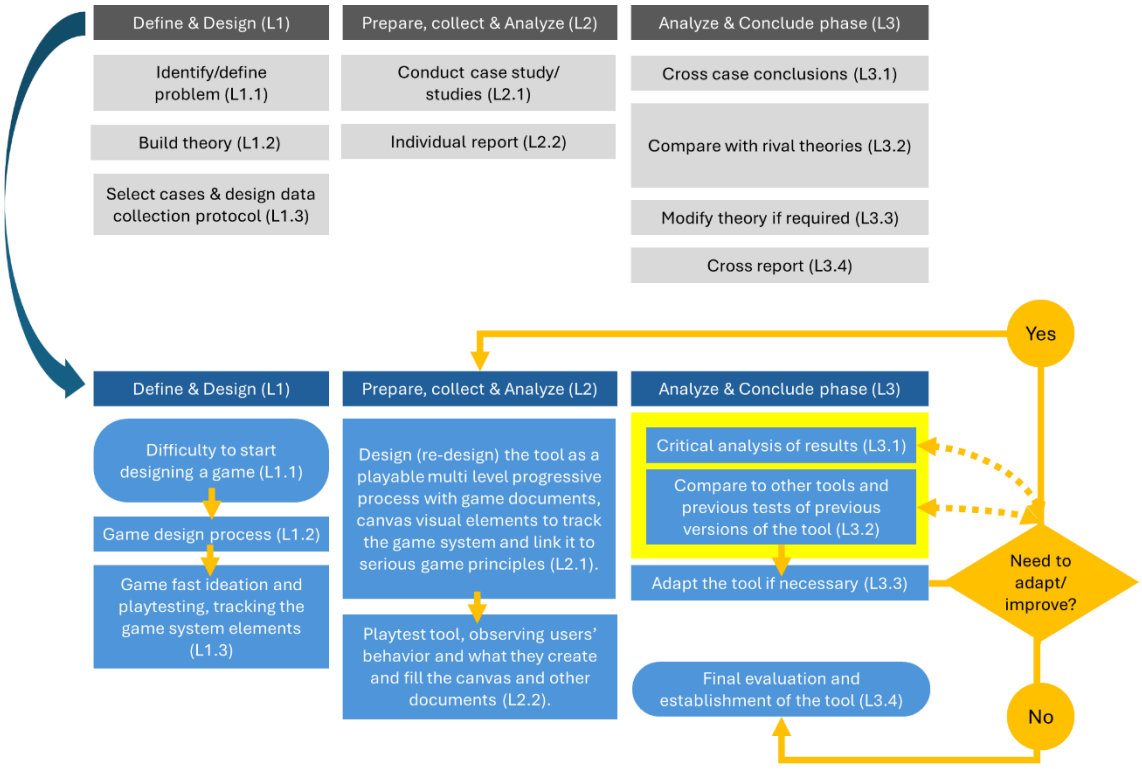

Figure 2. Adapting Teegavarapu et al. [34] guidelines for case study and design research principles to a game design and ideation process (including the playtesting and redesign loop) for MACMEO.

3.2 How the failed first solution defined the method for the framework improvement

In the Define & Desing (Figure 2, L1), we departed from our research questions and primary motivation. It is difficult for newcomers to systematically start designing a serious game (Figure 2, L1.1) (RQ1 and RQ3). The process was the analog development of the game to

design any game type (analog/digital/hybrid) (Figure 2, L1.2), following the influence of the MDA framework and its variations that are fitted for practical implementations during playtesting (RQ2). The analog dimension of the game allows fast implementation and testing (RQ4). Still, we developed a canvas/form for students to fill out as they were designing the game to track the game elements, the interconnections as a system, and the relationships with the serious goals/purposes of the game (RQ1).

Figure 3 presents the first canvas solution, following the concepts of core and auxiliary mechanisms as an adaptation of analog and digital classification of mechanics/mechanisms [16], [38], including the narrative dimension [31], the platform to play the games [21], and the purpose of the game to identify the serious game expected outcomes. These form/canvas arrows reinforce that the game dimensions are interconnected and bidirectional.

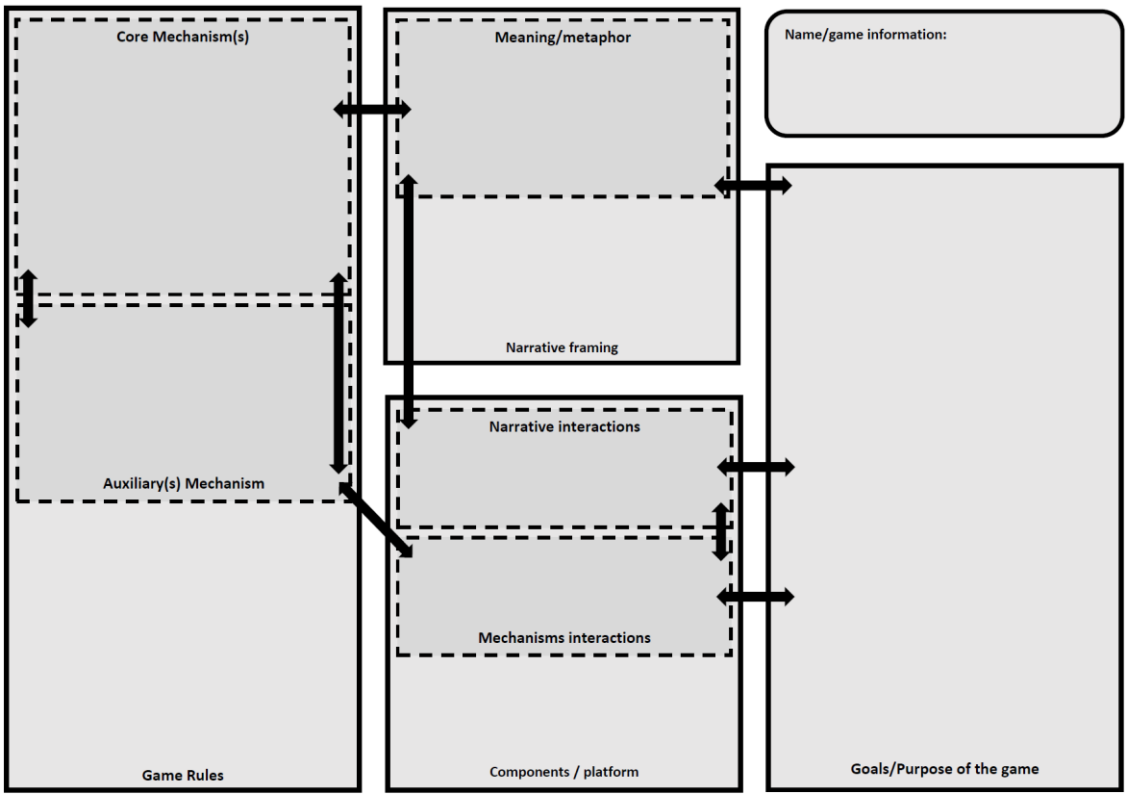

Figure 3. First canvas proposal for the MACMEO serious game design framework

We tested ourselves on the canvas when developing and analyzing our games. Still, students considered it difficult after a 25-hour training session (with expositive lectures and game experimentation). We had 16 students with no game design background for this previous training course, realizing they needed more support with concepts, like sets of mechanisms and how they interconnect with the narrative and the game platform. Not even starting from the game goals/purposes simplified the process. These testing and findings were part of the Prepare, Collect & Analyze phase adaptation, where the users tested the tool (Figure 2, L2).

Unlike other game design frameworks, none delivered such a rigid canvas solution. MDA and other related frameworks provide flexible processes but are not ready to be used as a playable canvas. This trait was either a difficulty or an opportunity to innovate. As tested, more than the expositive lectures about the game elements, mechanisms and others are needed to provide the required knowledge to students to use the canvas (Figure 2, L3). It failed because it did not help the students build their game prototypes. The solution was visual but not easy to use (RQ1).

After this session, we tested a new approach with health studies undergraduate students doing a serious games program (12 students). We proposed a canvas with an orthogonal grid divided into three sections (Goals | Experiences | Mechanisms/Components/Narrative) to place the mechanisms flashcards and let the students add the remaining information. This new canvas was easier to use, without arrows and restricted spaces beyond the sections for Goals/Experiences and Mechanisms/Components/Narrative), but students were still struggling with it. To compensate for the lack of arrows and other dimensions in the canvas, we created a Simple Game Design Document (SGDD) with a checklist and multiple-choice options of game characteristics [4], [39]. Despite the simplification effort, the initial set of mechanisms to choose from (a selection of 60 mechanisms flashcards) was overwhelming for students. The abstractness of the flashcards and lack of context compared to other game systems did not help either. Only with extensive teaching support were the students able to use the canvas and the game design documentation. This wasn't delivering a fast solution for prototyping (RQ2).

Testing gamification approaches to the MACMEO could be an option that would help students understand games as systems and identify and remember their elements while engaging the users to learn the concepts quickly. This solution might help address RQ1 and RQ2 while making the tool more engaging (RQ3).

The failures of the first solution (Figure 2) were what triggered the development of the process (section 4) that leads to the final version of the MACMEO framework (section 5). We tested and adapted this new approach during ten sessions (two to three hours on average), each time adapting and improving the tool by streamlining it (reducing the number of available mechanisms and proposing a simplified canvas for the framework dimensions I, II and III) and introducing gamified elements like the Mechanisms Game and the Running Game. Only after the framework was working could we test it as a process for digital game development (RQ4). We tested the initial ideas for the framework (Relational canvas from Figure 3 and the first approach for an orthogonal canvas) in two previous sessions, as mentioned before (both considered a failure). Then, it took four more sessions to reach the final MACMEO toolkit (see Table 1). The next section describes this process, the results, and the changes after each session. Section 5 presents the final version of the MACMEO framework, witch results from the adapted Teegavarapu et al. [34] guidelines (Figure 2).

- (Figure 2, L1) Define & design phase: Create flashcards, canvas, documents, and gamification elements as design solutions to tackle the challenge of supporting novices in making fast, serious game prototype.
- (Figure 2, L2) Prepare, collect, & Analyze phase: test the solutions in practical game design sessions.
- (Figure 2, L3) Analyze & conclude phase: analyze the sessions (observation), users' feedback, the game prototypes, and associated documentation. Redesign (Figure 2, L1) if necessary to improve the framework.

3.3 A method for defining the sessions

Considering the first experience with the first MACMEO canvas (figure 3), it was clear that the users' knowledge and background impact the tool's application and utility. We plan to do at least six more sessions but were able to run 10 sessions effectively. The first one should be conducted with experienced game design teachers and researchers (session 1) to test if there was a problem with game illiteracy. We classified the game design average knowledge/experience (GD) of the participants as low (Lw), medium (Md), and high (Hi) in Table 1 (grouping column). The following sessions were set for teachers, aiming to redefine the pedagogical dimension of the tool (sessions 2 and 3). After this, we wanted to test the framework with experienced analog gamers and students used to playing and doing prototypes (sessions 4, 5). Session 6 tested the potential of the framework to prototype digital game

solutions directly with game design students. Professionals and experts (outside game design fields) participated in the last sessions (sessions 7 to 10), allowing us to address all the research questions when introducing serious games for different work fields.

3.4 Data collection method

Teegavarapu et al. [34] adapted guidelines (Figure 2) require data collection from users' feedback and the overall outcomes of the sessions (game prototypes and their playability). We collected users' feedback through a pre- and post-session questionnaire on a 1-7 Likert scale. We ran informal focus groups after each session, analyzing and discussing all game prototypes with all the participants. We collected pictures of the canvas models, Simplified Game Design Document (SGDD) (see section 5.1.4), and overall pictures of the prototypes (example in Figure 10) for later analysis and redesign of the framework

4. Sessions and the improvement of the MACMEO

4.1 The sessions

After the first testing of the MACMEO framework, we set ten training sessions with various participants to test the framework and adapt changes until we get a final and improved solution for the tool. The sessions happened in different contexts, but with students learning game approaches for purposes beyond entertainment. Table 1 presents the details for each session, information about the students, the session's context, the framework adding/changes, and the game results. The features included in the evolution of the MACMEO framework are detailed in section 4.2.2.

Table 1. Synthesis of uses cases

S	Date	Number of participants	Duration (minutes)	Background of the session	Grouping (type of participants)	Included Feature
1	23-9-2022	11	120	Simulation and Game Conference for researchers	Game researchers, professors, and game creators. GD: Hi	Using board game tiles with 36 game mechanisms to replace 60 flashcards. Adding The Running Game first version as an example and the matching game.
2	28-09-2022	8	150	Training session for the use of board games as serious games for trainers	General teachers and trainers with extensive teaching experience. GD: Lw	Introduction of the gamification approach with the tiles: trading and the memory game. Improving the graphics and tips for The Running Game (Figure 8).
3	12-10-2022	7	120	Learning innovation conference for teachers	Teachers and trainers with high pedagogical expertise and research skills. GD: Lw	Adding the game design document form and creating new tiles (colorful and with high contrast) to distinguish the type of mechanisms
4	14-10-2022	6	150	Guest lecture for videogame master's degree	Gamers and Game creators finalizing their degrees. GD: Md	Adding the game flowchart as state machine approach for the game
5	22-10-2022	12	120	Board game convention for hobby audience	Hobby Gamers and Game creators with	Defining a theme for the serious game.

					extensive experience. GD: Md	
6	16-11-2022	9	300	Game design lecture for product design bachelor program	Gamers and Game creators finalizing their degrees. GD: Md	Design a hybrid or digital game.
7	3-12-2022	6	150	Game design course in a faculty of economics	Business Applications with senior professionals. GD: Lw	Define a serious game goal and build a game for it.
8	10-02-2022	4	120	Lecture for health researchers	Heath Applications gamers and game researchers GD: Lw	Define a serious fame goal and build a game for it.
9	21-04-2023	8	150	Training session on the use of games for university professors	Teachers and trainers with senior experience teaching in universities. GD: Lw	Define a serious fame goal and build a game for it.
10	1-11-2023	7	150	Training session about serious games in an MBA	Business Applications with senior professionals. GD: Lw	Define a serious fame goal and build a game for it.

The sessions (S) list presented different backgrounds and types of students. S1 (GD:Hi), S4, S5, S6, and S8 (GD:Md) were done in a context where the students had high or medium experience, and some were already game designers or heavy gamers. The participants aimed to build analog, hybrid, or digital game prototypes. S6 helped test the application of the framework for digital game development.

S2 and S9 participants were teachers or trainers seeking new knowledge and tools to use game-based learning approaches. The participants' overall game literacy was not as deep as that of the gamers and game creator sessions (GD:Lw). S7 and S10 were included in business training programs for company management. Here, the participants had many different backgrounds. Here, the participants had many different backgrounds. S8 participants were serious game researchers working in the analysis of health field but with limited knowledge developing games.

4.2 The evolution and introduction of new features in the MACMEO framework

4.2.1 Session 1 (S1)

In S1, all the students working in groups were able to create some playable game prototypes. The simpler games were tested several times, while complex games were not fully defined. Students developed, playtested, and described the game prototype using the MACMEO canvas and mechanisms tiles. However, it was unclear if the matching games helped students learn how to identify new game mechanisms (Mechanisms game: matching mechanisms tiles/flashcards on top of the mechanisms boards as fast as possible). There was no evidence that it was a conscious matching, knowing why they were doing the matching.

Before creating the game, the students use the mechanisms tiles (previous flashcards) and board in a matching exercise to help them remember the mechanisms. The mechanism tiles are composed of two squares side by side, along with the mechanism icon and text description. Students played it without reading the detailed information on the tiles/boards.

After the matching game (Mechanism Game), students played the Running Game with a roll and move race game. For each turn, the active player decides the dice to roll and move (D6, D12, or D20). D6 allows the advancement of that number of spaces. D12 works similarly but is lost if the value is lower than 6. The D20 is risky because results below 10 make the player go back, and the values above go forward. The purpose of this game was to depart from a traditional and mass-market board game type, adding some decisions related to dice and push-your-luck mechanisms. The game is used as an example to introduce the MACMEO canvas and how to use the mechanism tiles in the canvas to describe game system elements. This exemplification helped the users because they could consult the example when filling in the documentation for the game they were creating.

4.2.2 Session 2 and 3

For session 2, we used a gamification approach for the mechanism tiles, aiming to reinforce the dynamic of the sessions, the collaboration between the groups creating the games, and the learning of the mechanisms (Mechanism Game).

First, we select a set of tiles (one copy for each mechanism) per group of students, shuffle them, and deal 36 tiles for each group. The goal is to cover the tiles in three boards with all the mechanisms (the matching game, see Figures 5, 6, and 7). But this is only possible by trading the tiles with the other groups. The first group to finish wins. Trading the tiles was required to describe the mechanisms to other participants and discuss what was missing or not between teammates. This interaction and components analysis (tiles and boards) forced players to have a higher level of understanding of the mechanisms that had not been present before.

The second part uses new boards, covering the previous ones. Here, only the description is available (icons are missing). Then, students get the new tiles with icons representing the mechanisms (half of the original tile, without the text). This forces the player to read the descriptions on the board and match the correct icons. The first group to finish must stop the time for the others. Then, the score is the number of correctly placed icons next to the correct text.

The previous gamification additions energized the session and created a dynamic and collaborative environment for game creation. The improved version of The Running Game, with graphical references to the dice and other rule reminders, generated better gameplay experiences (Figure 8).

However, game literacy also affected the development of the games. Students discussed game ideas and used the MACMEO materials, but some did not develop their ideas into playable prototypes.

Session 3 was very similar. Increasing the colors and contrast of the tiles helped the students handle them. The introduction of SGDD consumed more time but worked as framing, allowing the students to question their game characteristics and goals. We found that providing more context is important. The framework is not self-explanatory.

4.2.3 Session 4

In session 4, students tested many game solutions beyond their first ideas. Some had so many ideas that they instantaneously tested the framework's ability to represent evolving conceptual game systems as they moved the tiles into the canvas and played with the available game pieces. Students were experimenting with how the mechanisms could connect to the narrative and digital implementations of the prototype. They created several parallel groupings of the mechanisms and had to write extra mechanism tiles for the different game parts because they

already used their only tile copy. The table and grid format of the canvas allowed this adaptation. The apparent success in this session might be related to higher experience and game design knowledge (GD: M), while in sessions 2 and 3, participants were less experienced.

4.2.4 Session 5

In session 5, we reinforced the serious game dimension as the students had to define a goal for the game as the first activity, one beyond entertainment, to enter the serious game domain. The main difficulty was setting this goal. Once the goal was settled, the MACMEO canvas proved to work when filled from the goals to the mechanical side of the system (canvas table), finding the best mechanisms, components, and narratives to build an experience that aimed for specific goals beyond entertainment. The mechanical solutions emerged connected to the goals and were immediately tested and recorded on canvas. The main finding was reinforcing that the MACMEO framework works in a multidirectional way; starting from the serious game goals and purposes is a recommended approach because it reduces the blocking in the ideation process.

4.2.5 Session 6

Session 6 outcomes were a mix between sessions 4 and 5. Students had to start with a predefined serious game goal. They already knew what type of project they should build a game solution for, including AR/VR or other digital solutions. The MACMEO was tested as a tool to prototype these solutions analogously. All students successfully create their prototypes and test them with other users. Then, they implement these mockups on digital platforms. They benefited from having extra time to test, track and improve their analog prototypes. The difference was that the sessions were part of their undergraduate program. Besides the positive result of using it to prototype digital games, the framework can be introduced into game design courses without major constraints due to its fast process.

4.2.6 Session 7, 8 and 9

In sessions 7, 8, and 9, we tested the MACMEO framework without additional changes. All the students were able to propose playable solutions, filling the canvas and the SGDD, with half of them doing several playtests of the games for business applications. At least one-third included digital platforms for their solutions, or the possibility of working in a digital environment. The users of these last sessions were professionals seeking to use serious games in their projects and activities, which means that the framework was useful as a first step into serious gaming from a hands-on approach.

4.3 Successful game examples generated by the MACMEO framework

Table 2 presents some of the most significant examples of games created using the MACMEO framework. We selected one game example from each session to illustrate practical examples of the outcome and type of game generated.

Table 2. Selection of the most significant games generated in each session by using MACMEO framework

S	Total games	Viable games	Game System summary (I) - Selection of one game example	Game experience (II) and Game Purpose (III) - Selection of one game example
1	3	2	Cards as limited resources to play in a board with bluff and social manipulation	Managing a conflict, with minimal clashes.
2	2	2	Allocation of pawns to boxes with limited space and according to set collection mechanics	Game about managing tables at weddings, respecting guests' preferences.

3	2	1	Roll and move game where there are multiple paths to follow and bumping the pawns.	Game for children (6 to 8 years old), to help them do simple calculus and trace paths.
4	2	2	Pattern movement pirate game, where the wind is represented by spinners and dexterity mechanics represent unstable cargo. Hidden information on the map.	Game about exploration, taking into consideration resource and cargo logistics.
5	3	2	Bags represent a marine ecosystem where players take and add cubes. Pattern movement of boats and aquatic ludic activities in a map where bags are located.	Game about sustainable fishing in a river and conflicting activities like maritime transportation.
6	3	3	Dexterity game about sliding discs over a map with a scoring system printed. Using contract cards to define players' objectives for the game (place for the discs)	Dexterity game to train motor skills as a prototype to implement into a virtual reality platform.
7	2	2	Action points as the measures a government can take to plan for policies. Map that represents the available resources and population. Areas and connections represent relationships and travel distances.	Game about the requirements to increase a demographics.
8	2	1	Cards with events placed near each other, and colored pawns to secure part of them as new cards are added and hidden.	Game for training in linguistic memory.
9	4	3	Standard playing cards that represent housing here players can bid, placing cubes and winning on majorities. The value of the cards is modified according to adjacent cards and sticks that represent the transport system.	Real-estate simulator, depicting the action elements and how the market demand affects prices as well as the surrounding and accessibility issues.
10	3	2	Cards as warehouses that get materials. Colored pawns with numbers that represent clients. A spinner that defines the economic conjuncture and changes according to a timer.	Wherehouse management and planning for unexpected economic conjunctures.

4.4 The students' perspectives

As part of the research design approach, we collected the students' perspectives after using the MACMEO framework. We asked students to classify (using a Likert scale of 1 to 7) how they perceived the usefulness (practical) of the gamified part to learn the game mechanisms (Mechanisms games), the game example (Running game), and its analysis according to the MACMEO framework, and the overall application of the MACMEO framework (Overall MACMEO) during the creation of the serious games as a tool. Table 3 shows Median (M) values due to the reduced size of each session participant (RQ1, RQ2, RQ3).

Table 3. Students´ evaluation of the several stages of the MACMEO framework (Median – M values)

S	Mechanisms games			The Running Game			Overall MACMEO		
	Useful	UI/UX	Fun	Useful	UI/UX	Fun	Useful	UI/UX	Fun
1	4.0	4.0	5.0	6.0	5.0	6.0	6.0	6.0	6.0
2	6.0	6.0	5.5	6.0	6.5	6.5	6.0	7.0	5.5
3	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0

4	7.0	6.5	6.0	5.5	7.0	7.0	7.0	7.0	6.5
5	5.5	5.5	6.0	6.0	5.5	6.0	6.5	6.0	6.0
6	5.0	4.0	5.0	4.0	6.0	5.0	5.0	6.0	6.0
7	6.0	6.0	5.0	6.0	6.0	3.0	7.0	6.5	5.0
8	6.0	7.0	6.0	6.0	6.0	6.0	7.0	7.0	6.5
9	6.0	6.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
10	6.0	6.0	6.0	6.0	7.0	7.0	7.0	6.0	6.0

Because we wanted to collect the students' perceptions of using the MACMEO framework as a tool to develop mockups and analog prototypes for tabletop or digital games, we asked them before and after each session if designing analog game prototypes was helpful in digital game development (RQ4). Table 4 presents the Median (M) values for the students before and after each session and includes a direct variation comparison.

Table 4. Students' perspectives on using analog games for digital game development (M)

S	Before Session (M_B)	After Session (M_A)	Variation (M_{A-B})
1	5.0	6.0	+1.0
2	5.5	6.5	+1.0
3	4.0	6.0	+2.0
4	6.5	7.0	+0.5
5	6.5	7.0	+0.5
6	5.0	6.0	+1.0
7	6.0	6.0	+0.0
8	5.5	5.5	+0.0
9	6.5	7.0	+0.5
10	7.0	7.0	+0.0

5. The MACMEO framework: the updated version ready to use

5.1 The latest version

As described before, the MACMEO framework evolved to be more straightforward and flexible, allowing newcomers to use it. The framework is not meant to be static; users can adapt it (the toolkit and other elements) as we did during the development process (section 4). Gamification approaches aim to engage the users and present them with the game mechanisms. To follow the MDA logic and include the narrative dimensions, the game components and the purposes of a serious game, MACMEO uses a specific canvas template and the mechanisms tiles. The SGDD also changed as the overall process and sessions happened, including more game design jargon and technical terms seen in the literature [4], [16], [39]. However, many of these terms and how they are interpreted may vary from game designer to game designer

Figure 4 presents the stages and substages of the MACMEO framework and the necessary materials to implement it. The following subsections describe how to implement them.

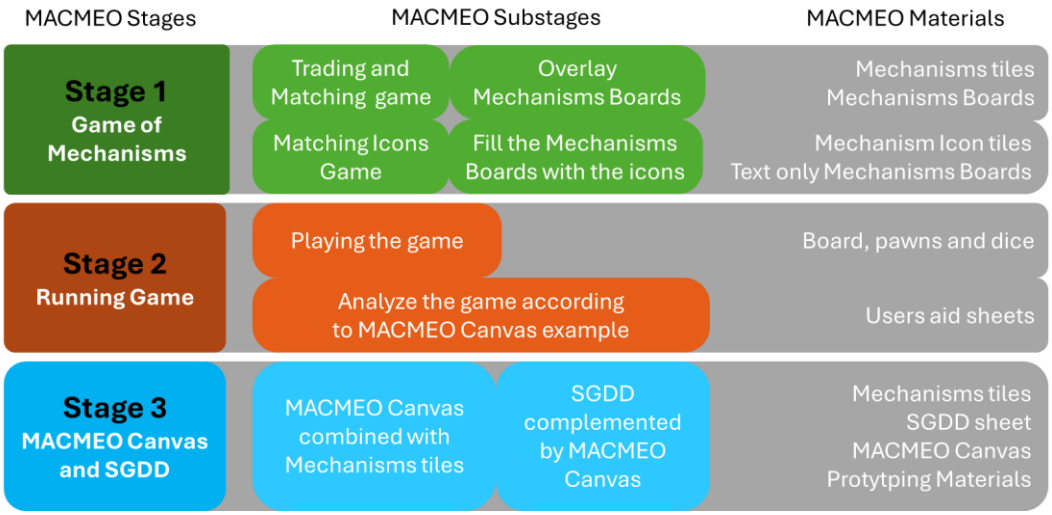

Figure 4. The MACMEO framework stage by stage, substages and materials (Appendix)

5.1.1 MACMEO: Stage1

As described before, in Stage 1, each group of students gets a set of mechanism tiles and three boards (flash cards). The 36 rectangular tiles (two squares) with icons and respective text (12 per board; see Figures 5, 6, 7) are exact replicas of the Mechanisms Boards (1,2 and 3) and the mechanisms flashcards. The 36 different tiles per group are mixed, and each group gets a new set of 36 random tiles. The Trading Game aims to establish a collaborative environment and learn/remember the mechanisms. Players trade and overlay the tiles on the Mechanisms Boards, like a tile placement and overlaying game. The first group to complete the task wins.

Figure 5. Core Mechanisms Board (Mechanisms Board 1/ mechanism flashcards).

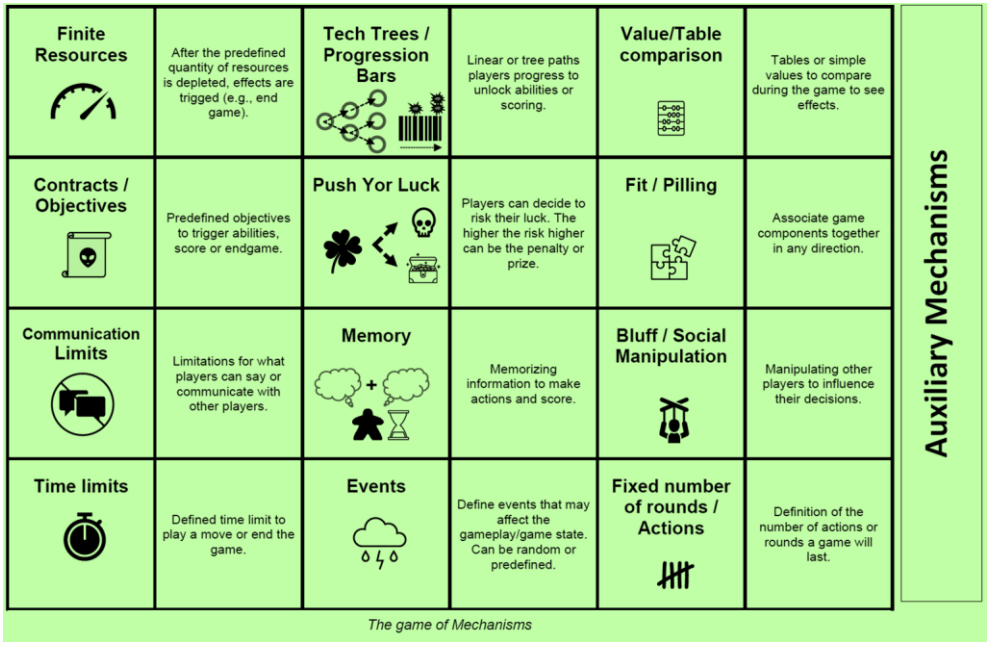

Figure 6. Auxiliary Mechanisms Board (Mechanisms Board 2/ mechanism flashcards).

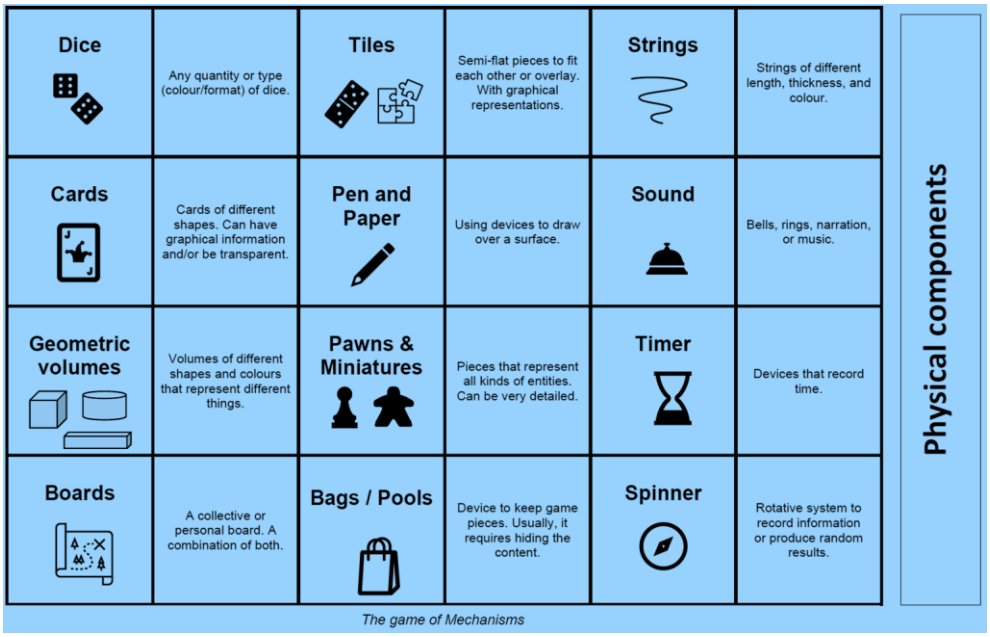

Figure 7. Components Board (Mechanisms board 3/ mechanism flashcards).

Substage 1.2 is the Matching icons game (part of the Game of Mechanism). Players cover the previous boards and add a new board over each previous one. The new Mechanisms Boards miss the icons and only show the texts. Players get a new set of squared tiles for all the mechanism's icons. Players must place the icon tiles in the empty spaces, connecting them to the text. After one group ends, all groups stop. Players remove the board with the missing icon and compare it to the previous one to count the correct matches. These tiles and boards are available in the Appendix (printing and cutting the tiles).

5.1.2 MACMEO: Stage2

In stage 2, players play The Running game. It's a roll-and-move game. The goal is to reach the end first by rolling dice. With each turn, the active player chooses the dice to roll. Each dice has a positive and neutral/negative proportional effect (see Figure 8).

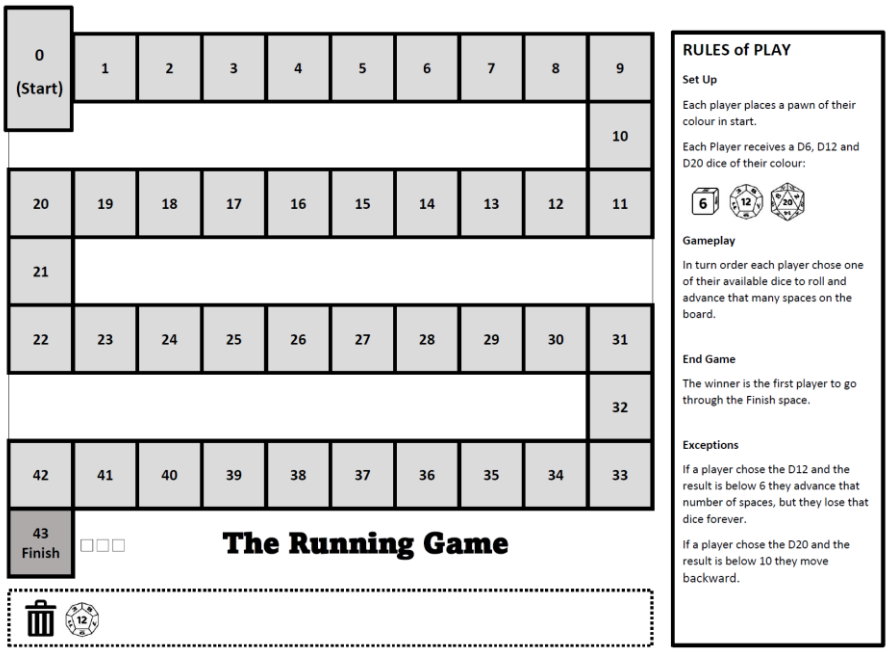

Figure 8. The Running Game board

After playing The Running Game, students are asked to identify the difference between standard roll and move games (usually those with D6 and no player decisions). The Running Game provides choices for students. These dice choices have a narrative meaning (e.g., effort management and risk injury). Then, the students get the MACMEO canvas describing the Running Game. The canvas transcribes the MACMEO framework (Figure 1) into a playable model (reinforcing the learning aspects of the framework as it departs from other influential ones). It explains how to use the Mechanisms tiles, grouping the mechanical elements and relating them to narrative meaning and the game goal beyond entertainment (see Figure 9). They can use as many mechanism tiles as necessary; they may divide the game system into game parts/sections to help them identify what mechanisms are used in each case, the metaphor, the experience, and how it is related to the serious goal of the game. Players can add arrows to reinforce connections between game parts/sections.

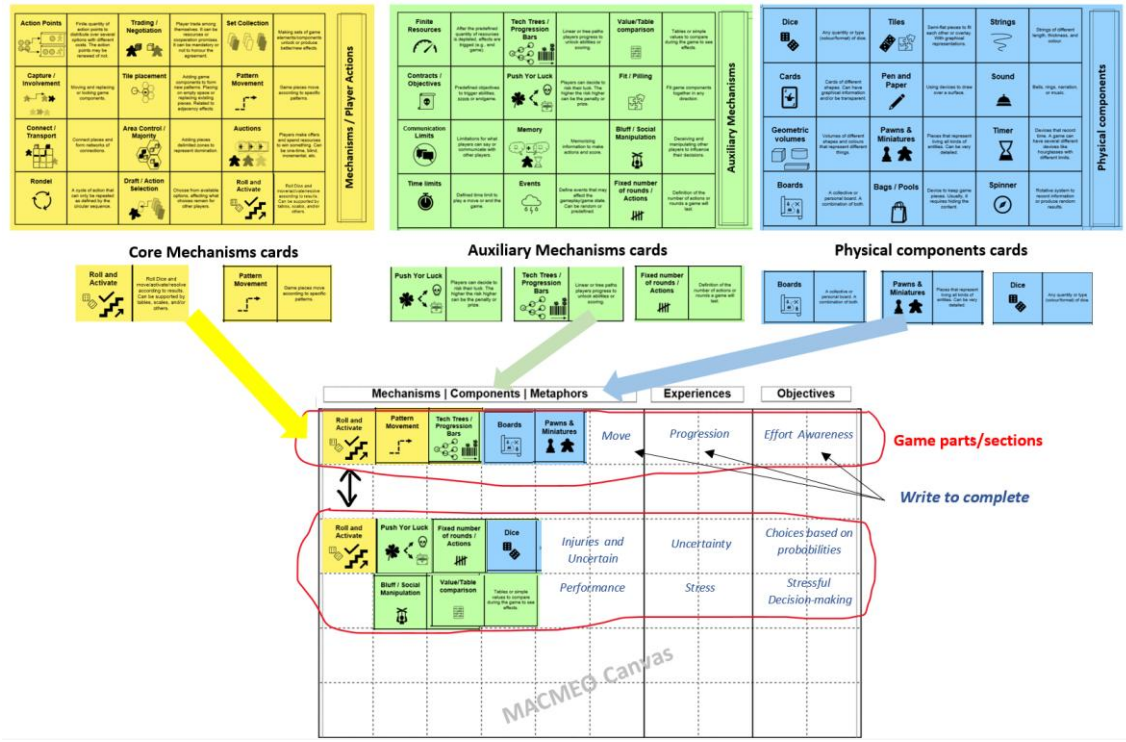

Figure 9. Example of filling the MACMEO Canvas to describe The Running Game

5.1.3 MACMEO: Stage3

For Stage 3, we need physical game components and bits like colored cubes and other shapes, pawns, cards, spinners, timers, and paper to cut to do tiles, boards, and other similar elements. The available components must match, at least, the ones in the Components Board (part of the Mechanisms Boards, Figure 7).

Each group can start prototyping and testing the game immediately and then fill in the MACMEO Canvas and SGDD or do it all together as they progress (Figure 10).

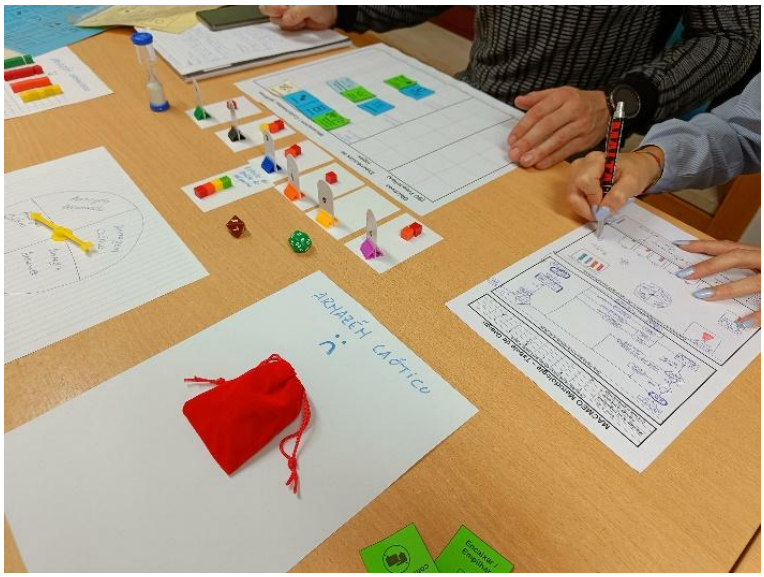

Figure 10. Example of the game design/development and use of the MACMEO framework (S10)

5.1.4 Detailing the Simple Game Design Document

The Simplified Game Design Document (SGDD) is an extra form of documentation (Figure 11) to complement the canvas template (Figure 9). It evolved as the testing of the MACMEO framework progressed, adding dimensions and correcting others. Some terms are due to subjective interpretations and are in the SGDD to trigger self-criticism when analyzing the games.

As the students fill it, they must decide/define the games:

- The game generic data: name, goal/purposes, target audiences, duration, similar games, etc.
- Game Structure: conflict system, time interactions, information, progression, setup, randomness, narrative.
- Game Space: definition of space, size, space modeling, spatial units.
- Players/avatars/entities
- Components/platforms/Graphics/Sound
- Mechanisms (represented in the MACMEO Canvas)
- Demanded skills: Mental/Cognitive, Physical/Motor, Social/Emotional.
- Graphical/semantic description of the game (scheme, etc.)
- Decision and mechanical scheme (estate machine, flowchart, etc.).

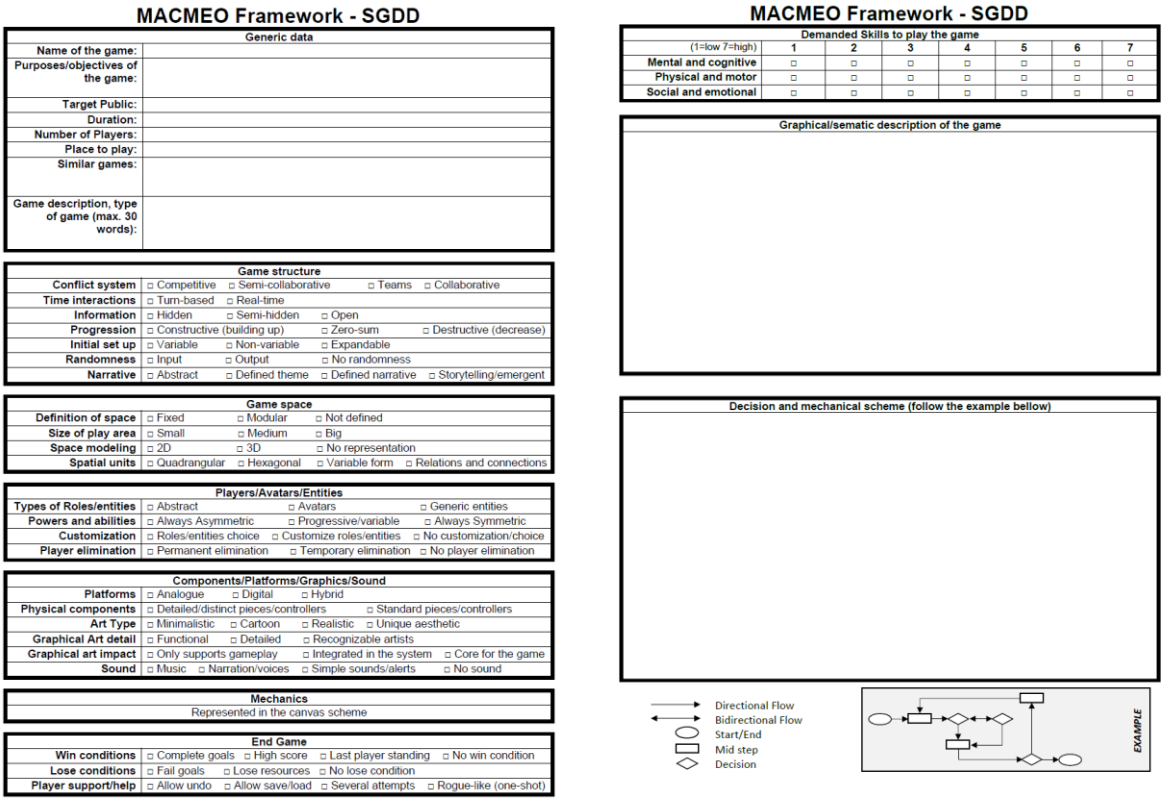

Figure 11. Example of the final version of the SGDD (front and back available in as an Appendix)

5.2 Recommendations based on testing and observations

After presenting the MACMEO Framework in applicable to development of serious games for many different situations, we can fully describe it as primarily designed for novices in serious game creation, aiming to scaffold their understanding of mechanisms, narratives, and components which is useful when playtesting and generating game design documentation.

However, we can identify some limitations in our testing process and the overall framework (detailed in the discussion section).

MACMEO can support fast serious game design exercises. It was useful to teach game systems visually while generating game documentation, but it was only effective in delivering simple games or limited parts of a deeper game. One hundred twenty minutes is enough to use as a first ideation and fast implementation of a game idea. However, using the MACMEO Canvas and SGDD in longer processes can be useful to track changes and design intentions. Users can use it as visual maps of the game structure, identifying the core and auxiliary mechanism and physical components by sections and how each relates to the metaphors and goals beyond entertainment. This tool's effectiveness relates to the users' previous experiences; it can detail or include a representation of the state machine and game economy. The SGDD helps to frame the game and reflect on the design choices.

On the practical side, teachers and trainers can use it easily by printing the boards and tiles and using standard generic game components and bits common for game prototyping (e.g., colored cubes, dice, and other bits; blank dice, cards, boards, and others). Users can reuse the boards and tiles, and the MACMEO canvas and SGDD can be saved to track the game versions.

The educators using the SGDD must analyze each term and adapt any if necessary because students will ask what some of the meanings are. These concepts in the SGDD (Figure 11) should be addressed in detail during standard expositive lectures.

We learned that bringing many physical game components for a session can be overwhelming and distract the students. Cubes, dice, timers, paper, and colored pens are enough. The goal is to prototype and mockup, either analog or digital, which means that abstraction is necessary and desirable for playing with ideas quickly. Another recommendation is to reinforce that the illustrations should come later because it can be time-consuming and jeopardize the conceptualization of the creation of the serious game system. We should remember we aimed for fast sessions as game development concerns (2 to 3 hours maximum). The MACMEO framework materials can be printed in standard printers and improved using cardboard or lamination techniques. The Game of Mechanisms requires the mechanisms boards (Appendix), and The Running Game is a print of Figure 8. Educators can use other variations or different games as long as they describe them using the framework as examples for students. But the basic and simple recommendations are:

- The MACMEO Canvas template (Figure 9) is available in the Appendix. We recommend printing it on an A3 blank background sheet.
- The Mechanisms Boards (Figure 5, 6 and 7) are available in the Appendix. We recommend printing two colored A3 sheets each, one for the board and another for the tiles (cutting them).
- The SGDD (Figure 11) can be printed in an A4 double-sided blank background sheet format.

6. Discussion

The adaptation of the Teegavarapu et al. [34] guidelines helped us implement a flexible approach (Figure 1). Testing and adapting the MACMEO framework during a sequence of 10 sessions with 78 different students allowed us to analyze its potential as a tool for rapid game design sessions.

All the groups in each session (S) were able to define some serious game ideas (26 in total); however, not all were able to playtest their early game prototypes (only 20 delivered viable games). We consider this a useful outcome and a considerable improvement as the framework evolved. All the students used the tool to draft the game system and the serious game goals (RQ1). 77% (20 games) were viable (fully playable prototypes), which means the time was

roughly enough to deliver the first prototype/mockup for a serious game project (RQ2). This finding means the durations of the sessions could be increased or divided into more sessions to have the necessary time for creativity and playtesting. However, even the ability to design ideas this fast has considerable value because creating a game can be a very long process when innovation and novelty are required. Despite these positive outcomes, we recognize that the generated games could be seen as the first ideas, especially for those aiming for hybrid or digital platforms. The mockups had to simplify many dimensions, like the controllers, the automatic refresh of the gamestate, feedback, and progression, without the visuals and sound that digital games use which affect the player experience. S6 students prototyped hybrid games, successfully playtesting their analog games to be implemented in AR/VR platforms. The games were simple dexterity games or mimicking 3D worlds where players moved pieces around to test effects. We did not test more complex games, but all prototypes worked in an analog format and were successfully replicated on digital platforms (S6). It helped playtest the game economy and the case of the games proposing dexterity "sports like" game activities (flicking discs in a battle arena). The other sessions that considered transforming their analog games into digital games were aimed more at the automation side of the game system and the ability to play remotely/asynchronously. Simulating massive multiplayer games is also a considerable limitation (only a limited set of interactions can be simulated this way). However, we should consider that the MACMEO framework is a prototyping and support tool for the beginning of a development process, not the tool to deliver a finished product.

We saw how introducing the gamification elements to the first stages, making the exercise of learning/reinforcing the knowledge of game mechanisms, improved the overall pleasantness and usefulness of using the framework (RQ 3). As the MACMEO framework was being adapted from session to session, students' perceptions about its usefulness increased and tended to be high on average (however, the participants were different in each session, limiting conclusive comparisons). Even students who were more experienced gamers or designers recognized it as a valuable tool (see Table 2). In S1, several students stated they did the matching game without thinking about what they were doing, just matching the icons. The final versions changed this, incentivizing players to read and analyze the information in the tiles and boards while playing a competitive game against the other groups. By observing the new dynamics between the groups, students were more engaged, and all competed and tried their best to win (M=5 or above; see Table 2) (RQ3). In session 6, the framework helped all the groups (3 in 3) deliver their first playable prototypes for future testing in digital platforms (RQ4).

Overall, The Running Game was seen as beneficial by students to learn how to use the MACMEO canvas template. The exception is S6, which is composed of game design students. They classified the usefulness of The Running Game as M=4. Although their perception of the overall use of the MACMEO was higher (M=5), they may have had more time to understand how it works with their own games. The other anomaly is S7, which was the one that considered The Running Game as less fun (3) and The Overall MACMEO Framework (5). However, S7 students considered all dimensions handy, with scores of 6 and 7. The lower scores might be related to their higher experience with analog games and their goal of learning how to design games for serious purposes (voluntary courses). Despite some low evaluation, we, as the observers and facilitators of the session, never noticed visible disengagement during the sessions at any stage.

Another interesting data analysis is that in all the sessions, the participants considered that, after experimenting with the MACMEO framework, analog game development helped develop digital games. S8 and S10 did not change but were already positive (M_A and M_B= 5.5 and 6.0). The most evident examples are those where the students were in a context and involved in creating digital games (S1, S4, and S6). Their perception increased, the MA-B was +1.0 in S1, +0.5 in S4, and +1.0 in S6. The higher increase (M_{A-B} = +2.0) happened in S3, where the students were teachers with experience using digital game-based approaches.

The overall positive feedback from users (students) reinforces the practical dimension of the MACMEO framework. The framework evolved as it is common in game development, testing it and correcting it according to users' feedback and product outcomes (games in this case). The framework can be presented as an educational toolkit that tackles the challenges of teaching game design and serious game design, bridging the theory to practice through a scaffolding process where users learn as they define and playtest, which ultimately fosters their game literacy, even when the games are far from being finalized. Nonetheless, there are limitations to consider, as we have seen previously.

7. Conclusion

Our process described the development of the MACMEO framework as a design research process, departing from initial conceptualizations of a tool to help newcomers start designing serious games using analog game prototyping. Going back to our research question, we wanted to test if proposing a practical framework (supported by a gamified toolkit) with analog templates and components to play and define the game systems would help the learning of serious game design. Teachers/educators can use the tool as a process to teach game design, meaning it is a learn-by-doing approach (with defined boundaries) in a format that could help newcomers and be useful for more expert users and even prototyping/mocking-up digital and hybrid serious games. We had a clear personal motivation, which we discovered we shared with other game design and serious design teachers and educators. We had to find new ways to help students develop their games, more systematized and faster, based on experimentation that allowed them to improve their projects as playtesting evolved.

Teachers and educators can use the MACMEO framework as a toolkit just by printing the materials in the Appendix and following the steps in section 5.1 (Figure 4), playing the Mechanisms Game, the Running Game, and then showing the examples of the Running Game to fill the canvas and SGDD. Teachers and educators can use the materials individually. The mechanisms flashcards can be adapted to more applications with gamified elements. The sessions have shown that defining a theme/goal for the serious game helps the students/users to focus and deliver game ideas faster. We also recommend limiting the number of generic game pieces, cubes, dice, and blank pieces of paper where players can write and draw enough to start, making it inexpensive.

During a year, the MACMEO framework was adapted and tested with many different users (students), following a process that allowed us to propose a practical toolkit. We argue that the results support the conclusion that the MACMEO framework contributes to the field of serious games by proposing a new gamified method that engages students to learn and create serious games (RQ3) through a fast, visual (RQ1 and RQ2) and adaptable to development of analog/digital/hybrid games (RQ4) while integrating well-established game design frameworks with serious-game goals (core concept of serious games). The results (game prototypes) appeared much faster than in our previous informal experiences teaching and conducting game design courses (our previous experiences and the two cases cited in section 3.2). In some of our previous informal experiences, no game idea materialized in several sessions. With MACMEO, all users were able to define game ideas, and 77% of the groups delivered playable prototypes.

We can conclude that the MACMEO framework is flexible enough to be used in different settings and provides fast sessions to introduce newcomers to game design and development. It proposed a gamification approach to learn board game mechanisms, a playable tool to represent serious game systems (MACMEO Canvas combined with the Mechanisms Tiles), and an introduction to a process of defining game elements and characteristics (SGDD) that later can be transformed into a standard Game Design Document for serious games (either

analog or digital). The framework is also simple to implement from a logistics perspective, easily printable, and combined with standard board and tabletop game pieces.

However, there are several limitations. We realized that more time might be necessary for some groups, especially those less familiar with analog game concepts and less game literacy (examples of different games, the ways game systems work in feedback loops, and their dimensions like mechanisms, components, and others). The information about the mechanisms is a reinforcing activity, although it helps to learn some new mechanisms. Learning how the mechanism works by doing Stage 1 (Game of Mechanisms, Figure 4) without other preparation may not be enough. Players must assimilate this information with more time and through more examples. The Running Game provides just one example of how to use the mechanisms tiles in the MACMEO Canvas template. However, defining each game part as part of a complex system and relating it to experiences and serious game goals is a challenge that requires considerable expertise. This way, we can recommend the MACMEO framework as an introduction and use it throughout longer analysis processes of different games and as continuous support for designing new serious games. Despite this, it worked as a fast way to get more ideas and playable prototypes. We should remember that 77% of the groups created fully playable prototypes (120 minutes on average). The limited number of mechanisms (36, including the game components and bits) can limit choices for more experienced users. The SGDD can be adapted and analyzed critically because our game design and development experience might bias some concepts. Some concepts might be interpreted differently as the SGDD form is very constraint and summarized. We highlight the main limitations of the MACMEO framework being tested during short-duration sessions that generated a considerable percentage (23%) of superficial and incomplete prototypes based only on a limited set of game mechanisms that might be very generic and unclear enough for novice game designers.

From a data analysis perspective, we only collected the students' quantitative perceptions, informal observations, comments and tracked the designed games. Future research could explore the users' experience in focus groups to better support the overall development of the framework. Testing with more educators using the framework is also a necessary future step to test its replication potential.

In conclusion, we believe the MACMEO framework is a valuable tool that provides a new solution for teaching game design for analog, hybrid, or digital games. We encourage educators who wish to use MACMEO to adapt for their use-cases and users. The analog format allows for reducing and simplifying the framework, removing some game mechanisms if the students are novices or adding more mechanisms if they have sufficient experience. The same is valid for the Simplified Game Design Document (SGDD), which can additionally be seen as a summary of game concepts to address in expositive lectures. Educators can introduce more games as examples to describe more game systems using the MACMEO framework. One possible exercise can be describing an existing game using the proposed flashcards/tiles (printing and cutting the mechanisms boards), canvas, and SGDD.

As we have seen, a practical game design framework for rapid prototyping and game documentation is scarce for serious game design, especially when guiding users to go beyond more standard and common game mechanisms that might reduce the serious game impact and the ability to simulate reality or scenarios. MDA and its variations are important but might be abstract and seem unstructured to newcomers. One of the advantages of the MACMEO framework is that it extends the MDA and proposes a tangible and practical toolkit that can be improved in the future and respond to the needs of students, educators, and overall users.

Conflicts of interest

The author declares that he has no conflicts of interest.

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