



ReanimaUdeC: An interactive serious game for basic CPR training in medical education

ReanimaUdeC: Un *serious game* interactivo para la enseñanza de RCP básica en educación médica

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Abstract:

Teaching basic Cardiopulmonary Resuscitation (CPR) is a priority in health education. Objective: The purpose of this study was to design and evaluate ReanimaUdeC, an interactive serious game for the self-directed learning of basic CPR among medical students. Method: The experience of 111 students (1st through 4th year) was evaluated using a sequential explanatory mixed-methods design, employing the Gameful Experience (GAMEX) scale and open-ended questions. Results: Participants reported high levels of enjoyment ($M = 4.18$), creative thinking ($M = 3.79$), and arousal ($M = 3.50$), along with low levels of negative affect ($M = 1.79$); no significant differences were observed by gender or year of study. Qualitative comments highlighted the educational utility, realism, and emotional satisfaction provided by the resource. Conclusion: ReanimaUdeC is an effective and equitable strategy for strengthening CPR competencies in medical education.

Keywords: Cardiopulmonary resuscitation, Health education, Medical education, Serious games.

Resumen:

La enseñanza de la Reanimación Cardiopulmonar (RCP) básica es prioritaria en la educación en salud. Objetivo: este estudio tuvo como propósito diseñar y evaluar

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ReanimaUdeC, un juego serio interactivo para el aprendizaje autónomo de RCP básica en estudiantes de medicina. Método: se evaluó la experiencia de 111 estudiantes (1º a 4º año) mediante un diseño mixto secuencial explicativo, utilizando la escala *Gameful Experience* (GAMEX) y preguntas abiertas. Resultados: los participantes reportaron altos niveles de disfrute ($M = 4,18$), pensamiento creativo ($M = 3,79$) y activación ($M = 3,50$), junto con bajos niveles de afecto negativo ($M = 1,79$); no se observaron diferencias significativas por género o año de formación. Los comentarios cualitativos destacaron la utilidad pedagógica, el realismo y la satisfacción emocional del recurso. Conclusión: ReanimaUdeC constituye una estrategia efectiva y equitativa para fortalecer competencias de RCP en educación médica.

Palabras clave: Reanimación cardiopulmonar, Educación en salud, Educación médica, Juegos serios.

1. INTRODUCTION

Teaching basic Cardiopulmonary Resuscitation (CPR) is a priority in health education, as its timely performance by trained personnel can double or even triple survival rates following cardiac arrest (Olasveengen et al., 2021; Panchal et al., 2020). The inclusion of this content in undergraduate curricula remains inconsistent or insufficient across many health sciences programmes. Alongside these longstanding curricular challenges, the COVID-19 pandemic tested conventional methods of clinical skills instruction, requiring the redesign of teaching modalities into virtual, asynchronous, and low-risk environments (Jadidi & Al Jufaili, 2023).

This context encouraged the adoption of digital resources such as clinical simulations, augmented reality platforms, and notably, serious games (Damaševičius et al., 2023; Olasveengen et al., 2021). These are defined as digital environments intentionally designed for educational purposes, incorporating game mechanics to foster meaningful learning in non-entertainment contexts (Cheng et al., 2024). Unlike gamification, which introduces isolated game elements (e.g., points, levels, rewards) into conventional learning environments, serious games constitute complete experiences structured around a narrative, decision-making, consequences, feedback, and performance-based progression (Cheng et al., 2024; Olasveengen et al., 2021). Their design is grounded in immersive narratives, coherent internal rules, and systemic feedback (Aster et al., 2024), allowing for greater emotional involvement and deeper learning. Evidence shows that they reinforce early recognition of cardiac arrest, improve response time, and build confidence to act during emergencies (Donoghue et al., 2024; Jadidi & Al Jufaili, 2023).

Through this justification, ReanimaUdeC was developed, an interactive film-based serious game created at the University of Concepción, Chile. Its purpose is to strengthen autonomous learning of basic CPR through an immersive, accessible, experience adapted to the local university environment. The game relies on a short interactive film, recorded on campus using medical students as actors, which allowed adaptation of the language and scenarios to the target age group. The present article describes the design process and the pedagogical and technological foundations of ReanimaUdeC, as well as the results of its evaluation using the Gameful Experience (GAMEX) scale. It further discusses the potential of such resources in higher education, particularly their impact on motivation, autonomy, emotional engagement, and the acquisition of essential life competencies.

2. OBJECTIVE(S)

The general objective is to design and evaluate ReanimaUdeC, an interactive video-based serious game, for autonomous learning of basic CPR among medicine students. We set two specific objectives, the first is to describe the pedagogic, narrative, technologic design process of ReanimaUdeC; the second is to evaluate the medicine

students' gameful experience through the GAMEX scale and identify gender and career year differences.

3. METHOD

3.1. Ethics statement

The GAMEX scale was administered through an anonymous online form, which included participants' informed consent. Confidentiality, respect for student autonomy, and the exclusive use of data for research purposes were guaranteed, in line with ethical principles established for studies in educational contexts. This study was approved by the Ethics Committee of the Faculty of Medicine, Universidad de Concepción (Approval Code: 15-2024, June 27, 2024).

3.2. Study Design

Our design aligns with the characteristics of an observational study. The study employed a cross-sectional observational research design using a mixed-methods approach, combining quantitative and qualitative data to provide a comprehensive understanding of the phenomenon under investigation.

3.3. Setting

The design of the serious game was carried out collaboratively and interdisciplinarily, integrating physicians and nurses specialised in CPR, health education specialists, higher education experts, game designers, computer engineers, and audiovisual professionals.

3.4. Participants

The sample consisted of 111 medical students in their 1st through 4th years: 26 first-year students, 21 second-year students, 31 third-year students, and 33 fourth-year students. Regarding gender, 66 participants identified as women and 45 as men. A census sampling method was used, inviting all students who had previously interacted with ReanimaUdeC to participate. Responses were considered complete if they included answers to all items on the GAMEX scale; forms with unanswered items, duplicate entries, and responses with completion times inconsistent with a careful reading of the instrument were excluded.

3.5. Variables

One of the most widely used instruments in Spanish-speaking contexts is the Gameful Experience (GAMEX) scale, originally developed by Eppmann et al. (2018) and validated into Spanish by Parra-González and Segura-Robles (2019). GAMEX enables a comprehensive evaluation of the player's experience, considering emotional, cognitive, and behavioural dimensions. It is structured into six categories: enjoyment, absorption,

creative thinking, activation, dominance, and absence of negative affect. These dimensions capture the degree of user engagement, perception of challenge, level of concentration, and emotions generated during the use of a serious game (Parra-González & Segura-Robles, 2019). In the case of ReanimaUdeC, the application of GAMEX has made it possible to explore not only the feasibility of the resource but also its educational value from the student's perspective.

3.6. Data sources and measurement

The research adopted a sequential explanatory mixed-methods design aimed at documenting the pedagogical design process and evaluating the user experience of the serious game ReanimaUdeC. In the first phase, a validated quantitative instrument was applied to characterise the gamified experience from a general perspective. Subsequently, qualitative data was incorporated through thematic analysis of open-ended comments, with the purpose of deepening the understanding of students' perceptions and complementing the quantitative findings (Ivankova et al., 2006). The serious game was conceived as a digital educational tool for teaching basic CPR in asynchronous virtual settings, aligned with the training recommendations of the American Heart Association (Panchal et al., 2020). The methodology was structured into three main phases, following and adapting the guidelines proposed by Olszewski and Wolbrink (2017) for the development of serious games in health education contexts. The logic underpinning these phases aligns with the chosen methodology: an initial stage of instructional design and resource development; a quantitative stage evaluating the user experience through the validated GAMEX instrument; and a qualitative stage aimed at further explaining the findings through thematic analysis. Finally, the results were integrated to provide a comprehensive interpretation that links pedagogical and technical evidence. This structure ensures the internal coherence of the study and supports its replicability in other contexts (Ivankova et al., 2006).

3.7. Implementation

The design of the serious game was carried out collaboratively and interdisciplinarily, integrating physicians and nurses specialised in CPR, health education specialists, higher education experts, game designers, computer engineers, and audiovisual professionals. This initial phase comprised three key actions:

Definition of pedagogical objectives: Goals were established in alignment with both the American Heart Association 2020 algorithm (Panchal et al., 2020) and the competencies outlined in the Medicine graduation profile at the Universidad de Concepción, including critical thinking, clinical decision-making under pressure, effective communication, and autonomous learning (Universidad de Concepción, 2008).

Narrative script development: The narrative was co-created with fifth-year medical students, who also acted in the leading roles of the game, aligning them with participatory design frameworks in educational innovation (Aster et al., 2024).

Design of environment and scenarios: The game was filmed on campus facilities, incorporating everyday language, youth cultural codes, and realistic situations to maximise users' sense of belonging—a strategy identified as essential in serious game design for increasing immersion (Aster et al., 2024; Dankbaar, 2017).

Additionally, the game is hosted on the web platform <https://educmed.cl/reanimaudec/> is registered under copyright number 2024-A7420, ensuring traceability and intellectual property protection.

3.8. Game design and mechanics

The game was implemented as an interactive film with branching paths, using the open-source software Twine (available at <https://twinery.org/>), a tool designed to create nonlinear interactive stories. With an average duration of 8 to 12 minutes, depending on individual performance, the narrative places the user in a simulated medical emergency in which a classmate collapses and loses consciousness. Throughout the story, players must make a sequence of 18 binary decisions (correct/incorrect), each of which directly affects the clinical outcome and the probability of survival. This chain of decisions creates a dynamic of problem-solving under pressure, positioning the player as the first responder. Immediate feedback after each choice reinforces learning, helping users identify mistakes and improve continuously, while the clinical story adapts to the user's decisions, reflecting the logic of real-life prehospital emergency scenarios.

3.9. Performance tracking

The system automatically records variables such as response time, correct decisions, errors, and final outcomes. This data allows for the generation of individualised reports for students, available upon request from the development team, thus contributing to personalised feedback.

3.10. Evaluation of user experience

To evaluate students' experience with ReanimaUdeC, the GAMEX scale was applied, validated into Spanish by Parra-González and Segura-Robles (2019). For the quantitative analysis, nonparametric tests (Mann–Whitney U, Kruskal–Wallis H) were used due to the ordinal nature of the GAMEX scale. Exact *p*-values and effect size measures were not calculated for comparisons by gender and year of training; this is acknowledged as a limitation of the analysis and is suggested as a direction for future research. For the qualitative analysis, an open-ended question was included at the end of the questionnaire to gather spontaneous comments. The responses were analyzed using manual inductive thematic coding, performed independently by two researchers; disagreements regarding the coding were resolved through the intervention of a third researcher, as a strategy to verify the reliability of the process (Galanis, 2018).

4. RESULTS

The evaluation of students' experience with the serious game ReanimaUdeC was conducted using a sequential explanatory mixed-methods approach, combining quantitative analysis through the GAMEX scale with qualitative analysis of open-ended comments. We have displayed the results of the scale in a visually friendly way as shown in Table 1.

Table 1
Results of gamified experiences

Variable	M	SD
Enjoyment	4.18	0.77
Creative Thinking	3.79	0.69
Activation	3.50	0.81
Domain	3.46	0.72

Note. Table 1 shows mean (M) and standard deviation (SD) of the parameters: Enjoyment M = 4.18 (SD 0.77); Creative Thinking M = 3.79 (SD 0.69); Activation M = 3.50 (SD 0.81); Domain M = 3.46 (SD 0.72). Own elaboration.

The highest-rated GAMEX dimensions were enjoyment (M = 4.18, SD = 0.77), creative thinking (M = 3.79, SD = 0.69), and activation (M = 3.50, SD = 0.81). The domain dimension also obtained a favourable score (M = 3.46, SD = 0.72). These results indicate that students perceived the serious game as both enjoyable and cognitively stimulating, while also recognising its capacity to promote engagement.

To guarantee equity and inclusion, Table 2 was created, as a way to display the differences of the GAMEX score in gender. No statistically significant differences were found.

Table 2
GAMEX scores by gender (N = 111)

GAMEX Dimension	Women (n = 66) M (SD)	Men (n = 45) M (SD)	P (Mann-Whitney U)
Enjoyment	4.23 (0.64)	4.11 (0.93)	0.746
Absorption	3.50 (1.07)	3.43 (0.97)	0.482

Creative Thinking	3.93 (0.75)	3.59 (0.91)	0.059
Activation	3.57 (0.71)	3.39 (0.88)	0.336
Absence of Negative Affect	1.79 (0.78)	1.78 (1.09)	0.220
Domain	3.51 (0.71)	3.43 (0.99)	0.846

Note. Table 2 shows GAMEX scores by gender (N = 111). No statistically significant differences were found between women and men in any dimension (all p are higher than .05, Mann-Whitney U). Own elaboration, based on the GAMEX response database.

Immersion and concentration:

The “Absorption” dimension presented a mean value ($M = 3.47$; $SD = 0.76$), indicating a moderate immersion experience. This can be interpreted as sustained attentional engagement without reaching a state of full abstraction from the physical environment.

Absence of negative emotions:

The “Absence of Negative Affect” dimension obtained the lowest value ($M = 1.79$; $SD = 0.59$), which, within the framework of this scale, is interpreted positively: it represents a low presence of emotions such as frustration, anxiety, or boredom.

Equity of the experience

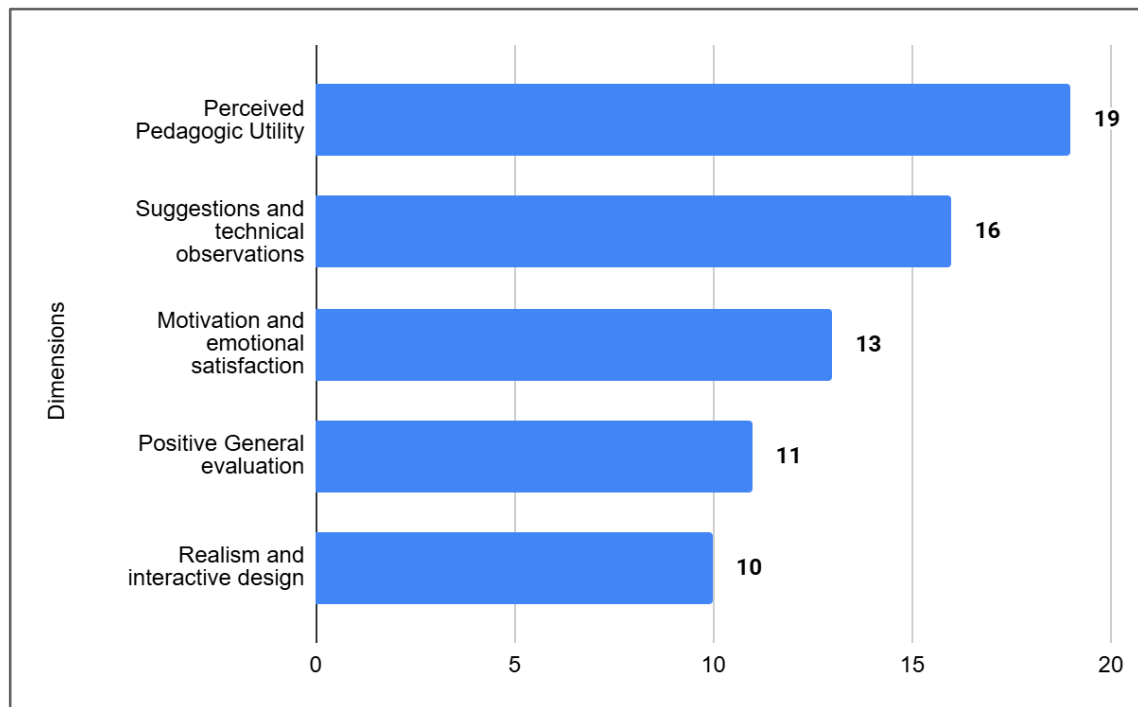
Non-parametric tests were applied to identify potential differences by gender (Mann–Whitney U) and age group (Kruskal–Wallis H). In neither case were statistically significant differences found ($p > .05$), which suggests that the experience was transversal, equitable, and inclusive.

Qualitative results: Open ended comments

The questionnaire included an open-ended question inviting students to share voluntary comments about their experience with the game. A total of 69 responses were analysed using inductive thematic coding, which allowed the identification of emerging categories without imposing a predefined structure, as shown in Figure 1.

Figure 1

Thematic dimensions



Note. Figure 1 shows frequency of thematic dimensions identified through inductive thematic analysis of open-ended student comments (N = 69). Own elaboration.

Perceived pedagogical utility

A dominant category was the recognition of the game as a learning tool. Students emphasised its usefulness in reinforcing prior knowledge, consolidating CPR sequences, and facilitating the understanding of the clinical algorithm:

“Excellent, I think I learned CPR skills I did not know.”

“It is an interactive game that serves as a learning tool.”

Realism and interactive design:

Several participants valued the context of the game, filmed in real campus settings with students as actors and youth-appropriate language.

“Very realistic game, and if it helps save real lives, even better.”

“Entertaining, very realistic. But I wanted to interact more.”

Emotional satisfaction and motivation

Students expressed high emotional satisfaction, using descriptors such as “entertaining,” “dynamic,” and “educational.” This category suggests that the emotional component is key for adherence to the resource:

“Excellent game, very educational, didactic, and dynamic.”

“It was very entertaining.”

Technical observations and suggestions:

Some students reported minor issues, mainly related to mobile device compatibility or limited decision-making options.

“It did not work well with the iPhone, and that made me lose time.”

Overall positive evaluation:

A cross-cutting category was the overall positive evaluation of the resource, with comments describing it as useful, innovative, and desirable for implementation in other courses:

“Very good resource, I hope it will be used more in other subjects.”

“It is a great way to learn things that can save lives.”

5. DISCUSSION

The findings of this study demonstrate that ReanimaUdeC was perceived by students as an effective, emotionally positive, and motivating educational tool. The highest-rated GAMEX dimensions Enjoyment ($M = 4.18$), Creative Thinking ($M = 3.79$), and Activation ($M = 3.50$) support the hypothesis that well-designed serious games can generate immersive and meaningful learning experiences, even in asynchronous virtual contexts. This is consistent with recent literature on simulation and educational gamification in health (Cheng et al., 2024). The high score for Enjoyment aligns with previous studies highlighting how the playful and narrative components of serious games enhance intrinsic motivation, increase student engagement, and reinforce the consolidation of clinical knowledge (Dankbaar, 2017; Donoghue et al., 2024).

A particularly notable finding was the low score for Absence of Negative Affect ($M = 1.79$), which, within the framework of the scale, is interpreted positively. This indicates that the resource did not elicit emotions such as anxiety, frustration, or boredom. ReanimaUdeC managed to maintain a balance between challenge and enjoyment, aligning with the model of optimal experience. The qualitative comments further reinforce these findings, with students emphasising the game’s pedagogical value, realistic design, clarity of decision-making, and motivational impact. These aspects underscore the role of serious games not only as vehicles for content delivery but also as generators of positive emotions toward professional training, which, according to recent studies, is a key facilitator of meaningful learning (Cheng et al., 2024; Damaševičius et al., 2023).

Moreover, by enabling decision-making in a safe environment, the game offered a rehearsal space without negative consequences, thereby reducing the anxiety typically

associated with real clinical practice. Another significant aspect is the observed inclusivity: no statistically significant differences by gender or age were identified across any measured dimensions. This suggests that ReanimaUdeC was an inclusive and equitable experience. Accessibility, adaptability to student profiles, and the absence of design bias are fundamental conditions for advancing toward a more equitable medical education (Joy et al., 2024).

Finally, the design process itself held formative value for the developers. As described in the final report of the COLABORA project (C23-062), fifth-year medical students participated in the creation of the resource, acquiring additional competencies in collaborative work, effective communication, and instructional design. This is consistent with project-based learning approaches and contributes to the training of future reflective and innovative professionals.

The findings confirm that ReanimaUdeC was not only positively valued by students but also met multiple criteria of pedagogical, emotional, and technical quality. Its successful implementation opens the door to extending this strategy to other areas of health education, as well as validating similar resources across diverse curricular contexts.

Additionally, although nonparametric tests were used to compare groups by gender and year of training, the exact p-values and effect size measures are not reported, which constitutes a limitation of the statistical analysis. Future studies should incorporate these indicators to allow for a more precise interpretation of the magnitude of the differences (or their absence). Furthermore, the study design is non-experimental and lacks a control group, which limits the ability to attribute causality to the observed results.

6. CONCLUSIONS

ReanimaUdeC represents an innovative and replicable approach to health education in asynchronous virtual settings. Students perceived the experience as enjoyable, motivating, and emotionally safe, highlighting its value as a tool that integrates technical, emotional, and pedagogical dimensions. The game strengthened critical thinking and clinical decision-making in a safe environment, while its branching narrative and performance tracking added technical and instructional value. These findings support the integration of serious games into medical curricula and their adaptation to other disciplines and contexts.

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