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Designing and Evaluating a SG for Learning: a Subtle Balance Between Designers and Learners

Longeon Thomas¹, Furnon Cindy¹, Marfisi-Schottman Iza²[0000-0002-2046-6698]

¹IFP43 - CFA Interprofessionnel de Haute-Loire, France

²Le Mans Université, LIUM, 72085 Le Mans, France

Abstract

In a learning context marked by the disengagement of learners causing difficulty in developing skills, profound changes to diversify approaches have been initiated through pedagogical strategies and training systems to create commitment, generate motivation and thus promote learning. Through the literature and eXperience Feedback, the design and use of Serious Games (SG) appears to be an effective and efficient approach to creating an engaging and motivating context.

Through this communication, we define a theoretical framework around the design of SGs and we propose elements of response with an iterative design method of the design-based research type at the service of pedagogical engineering and skills development. We will show that the design phases of an SG articulated around the “10 commandments of the Serious Game Padawan” and combined with the exploitation of traces (learners, designers) lead to an approach having measurable impacts on the development of skills and the appropriation of the SG in a professional context. Thus, we highlight the subtle balance that is exercised between research, design, development, feedback from the SG through a comparative approach between traditional pedagogy versus active pedagogy based on the use of a SG.

Keywords: serious games, gamification, design, play and learn, design by learning

1 Introduction

Much research on games, education and psychology show that its use allows to “construct the experiential existence of man” [1] bringing a symbolic function conceding in particular the construction of identity, the development of relationships social, skills and motor coordination. Indeed, Kergomard P. promotes games and toys in the official texts of Education: “play is the work of the child, it is his job, it is his life” [2]. This pedagogical approach, very present during the first years of the educational course, is gradually being abandoned. The ambition, through the edutainment modality, is to mobilize game mechanics by repositioning learners at the heart of the learning process, making them actors in their training while promoting commitment and the anchoring of knowledge. The Serious Games (SG), by their immersive capacity, have found their place in the world of education and “offer in the

range of active pedagogies, a privileged means of involving learners, in particular by immersion in a universe realistic” [3] and thus becomes an adaptive learning engine.

2 Observation and problems

First, we note that the heterogeneity of learners and the multiplicity of training provided raise organizational difficulties, both from the point of view of the establishment, the teachers and the learners. This first observation has consequences on the motivation and commitment of learners that are difficult to initiate and maintain throughout the training course. The teacher must therefore constantly imagine new strategies and design teaching methods and artefacts to maintain the motivational flow.

Secondly, the role of teachers through literature is similar to that of an “artisan” where “pedagogical practice oscillates between regulated improvisation and tinkering” [4]. If we make the link with the continuous evolution of learning devices which leads to a complex modification of the roles of teachers and learners [5], we can determine two effects. The first is that “teachers become real designers who have the task of anticipating and relating, in one or more learning environments, different pedagogical, ergonomic, human, organizational parameters in an engineering process that goes from the design of the learning system to dissemination” [6]. The second leads teachers to abandon their “pedagogical do-it-yourself” to move towards an elaborate and effective orchestration [7].

Thirdly, the new generations of learners (Generations Z and Alpha) [8] lead to thinking about new strategies and teaching tools. We find, in the literature, the components that define this new generation of learners [9]: motivation by affect, need for recognition, difficulty in accepting constructive criticism, diminished sense of responsibility, little link between the effort and the result.

Faced with these findings, since 2021 we have been carrying out a reflective and active approach around ludopedagogy and in particular on the design of SG in the service of skills development. We present our combinatorial methodology around a theoretical framework as well as the first results of the study.

3 Theoretical Framework

Through the literature and much feedbacks, the use of SGs in combination with other tools used by teachers appears to be a probable solution for creating the conditions for engagement in learning and thus maintaining motivation. Enough to develop skills [10]. As part of an active pedagogical approach and design of SG, it is advisable to carefully consider, from the genesis of the pedagogical artefact, the needs of the various actors linking motivation, commitment, immersion and pedagogical strategies [11].

3.1 Motivational Lever

Motivation theory is a set of principles that describe how and why individuals are motivated to act in a certain way. There are many theories of motivation, each with their own key assumptions and concepts. Thus, we highlight the theory of intrinsic and extrinsic motivation, which can be applied and transposed to SG [12]. Intrinsic motivation theory asserts that individuals are motivated by the personal satisfaction they derive from an activity while extrinsic motivation theory asserts that individuals are motivated by rewards or penalties associated with an activity. SGs can thus use these two motivational levers by creating playful and enriching situations for learners by offering feedback to encourage and promote good performance. Games can also use the self-determination theory of motivation [13] which argues that individuals must feel in control of their lives and their environment to be motivated. Games that offer choices and options in the unfolding of the game scenario can therefore help players feel more in control of their immersive experience and therefore be more motivated.

3.2 Interactions Between Learners

Stimulating pedagogical interactions between learners is a key concept in group learning. These are verbal exchanges and non-verbal signals that take place between learners working collectively towards a common goal. Pedagogical interactions can be formal, such as debates and guided discussions, or informal, such as exchanges of knowledge and personal experiences [14]. These interdependencies can therefore enhance learning by allowing learners to share knowledge and experiences, ask questions, receive feedback and ideas, and motivate each other. Educational interactions can also encourage learners to develop important social skills, such as active listening, conflict resolution, and group decision-making [10]. There are different transferable strategies in SGs to promote interactions, for example by using technological tools for online collaboration, by creating learning situations that promote group discussions, or by using active methods that involve learners in the problem solving and debating [15]. Teachers can also use facilitation techniques to guide learners to build positive relationships and communicate effectively with each other [16].

3.3 Concrete Representations

Offering concrete representations with SGs is a strategy to support learners' understanding by promoting the retention of new information and memory anchoring. Concrete representations are objects or images that illustrate abstract concepts. These can be transposed into SG, notably through the mediation of images, animations, simulations and visualizations to address difficult concepts [17]. In addition, concrete representations can help learners assimilate ideas or skills by linking them to familiar images or objects.

4 Serious Game Design

4.1 Serious Game Design Method

The design requires a reflective approach to create a conceptual balance that reflects and serves the learners. Thus, we based ourselves on a design-based research type methodology seeking to solve the problems of learning, skills development, pedagogical engineering mobilized in the design. By placing ourselves in this combinatorial methodology, we are part of a dynamic of emergence of ideas which will be discussed, prototyped, tested and analyzed throughout the development process. First of all, our research approach is based on a pedagogical engineering model allowing analysis, design, development and evaluation. Thus, we favored an iterative approach based on the successive approximation model [19]. This model encourages quick feedback and flexible work processes. The methodology of Design-Oriented Research [21] is based on the idea that the design of pedagogical artefacts or training devices requires the formalization of researcher-teacher relations around strong collaboration, sharing of praxeologies and implementation. place of tools allowing the exchanges between research and field of experimentation. Reference is often made in the literature to the “classic position, the research team ensures the development of tools, the conceptual approach, the collection and analysis of results, then yields to decision-makers and practitioners the initiative to 'adapt the knowledge produced, and even the instruments, to the local context” [21]. Thus we have built a combinatorial method allowing the crossing of visions: designers of SG/educational engineer, researchers, learners, teachers pooling and capitalizing the traces throughout the design iterations. In addition, we have completed our approach with the conceptual method of the “10 commandments of SG Padawan” which offers key steps and recommendations to help teachers create their own SG [11].

4.2 Realization of the Serious Game *Wonder Vendeur*

“*Wonder Vendeur* : devenir un vendeur qui déchire” is an SG in which learners play while developing their skills in sales and commerce. By immersing themselves in this universe, learners must go through all the stages of a sales interview by answering questions related to six educational objectives:

- Identify the eight key stages of the sales conversation.
- Master the techniques/methods and tools associated with each stage: active listening, identification of customer needs, removal of barriers to purchase, interpersonal skills, posture, etc.
- Use reception techniques/methods, search for needs, reformulation, presentation, argumentation, processing of objections, conclusion, associated with a transactional and relational loyalty method.
- Mobilize skills in a professional context.
- Evaluate and co-evaluate sales techniques/methods.
- Follow and trace the training course via an individual skills passport

This SG explores the activities and skills of «*Bac Professionnel Métiers du Commerce et de la Vente*», the «*Certificat d'Aptitude Professionnelle Equipier polyvalent du Commerce*», the «*Certificat d'Aptitude Professionnelle Métiers de la Coiffure*» and «*Brevet Professionnel Coiffure*»

To verify our hypotheses, we have implemented tools and techniques to mobilize and activate three motivational springs:

- Intrinsic motivation: mobilized through quests, challenges, progress in the game. It is activated by personal success using mechanics of rewards, ranking, *Wonder Vendeur* skills passport but also by exploration and creation (choice and personalization of an avatar).
- Extrinsic motivation: can be activated by promoting team play (guild/team), recognition and social belonging among players via the personalization of a team avatar.
- The combination of intrinsic motivation and self-determination: identifying with a personalized avatar, becoming an actor in its progression by choosing the feedback offered by the narrative structure of the SG.

Our serious game is made up of 700 cards, divided into four items that we describe below:

Items	Objectives
<i>Method</i>	Acquire and assess block skills: <ul style="list-style-type: none"> • Advise and sell / Accompany the customer in their purchase journey. • Customer relations and participation in the activity of the company / Advising and selling products, materials and services.
<i>Enigma</i>	Develop and acquire the skills expected in the other blocks of the repositories: tracking sales, building customer loyalty and developing customer relations, receiving and tracking orders, highlighting and supplying.
<i>Live my life</i>	Put into practice the knowledge to be expected in a professional context by confronting real situations.
<i>Brand</i>	Mobilize informal knowledge of general culture.

Tab. 1. Theme of the game *Wonder Vendeur*

The narrative structure of *Wonder Vendeur* mobilizes three anchoring methods to accompany and support learners to better assimilate concepts by associating them with images, sounds, interactions and/or familiar objects.

- Visual anchoring: all the stages of the sales interview present on the board and on the “Method” cards are represented by a single pictogram. Players implicitly associate the technical vocabulary of the stages of the sales conversation through these constituents. This strategy also enables allophone learners to associate pictograms with professional vocabulary. Finally, these are found on the training materials in order to form a cohesion and a link between the game and the

theoretical contributions, creating an educational ecosystem: each skill targeted in the course is associated with a game theme.

- Auditory anchoring: this anchoring process is also mobilized through the rules of the game. Indeed, the players must read the questions aloud to all the learners. If the player does not find the correct answer(s), the card is repositioned above the deck. Thus, players who have been attentive can memorize the answers and progress faster on the game board.
- Interactive anchoring: an interactive dimension is exploited via the implementation of QR-Codes readable from a personal digital tool. This strategy provides additional depth allowing the dissemination of slogans on the “Brand” item.

Given our problem of engaging and retaining learners in a training system, we have favored four pedagogical methods to mobilize, diversify and combine learning:

- Complete game session over 2 hours: acquisitions and/or revisions of the activities and skills expected by the reference systems.
- 30-minute focus session: the teacher can validate the professional skills developed and over a shorter session by using the *Wonder Vendeur* passport which certifies the passage of learners on a specific stage. This co-maintained link between the theoretical and practical contribution allows learners to measure their progress and retrace their training path.
- Fan mode: the cards can be used alone, thus offering a new playful dimension that promotes autonomy and the social interactions that result from it.
- Battle mode: the addition of a buzzer as a fun spring allows learners to compete by mobilizing the speed of response, thus enriching Wonder Vendor with a stimulating spring.

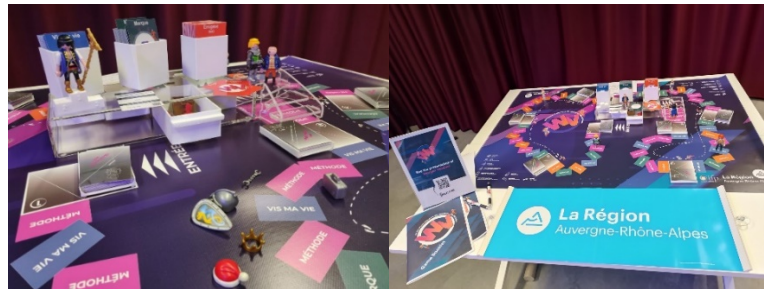


Fig. 1. The serious game *Wonder Vendeur*

5 Experimentations

5.1 Methodology for Feedback Collecting

The experimentation sessions mobilized the teacher-designer, an educational engineer, the learners and a researcher specialized in SG and EIAH. Thus, we propose

the adaptation of an observation tool [20] allowing the collection of data (observations, actions, positions, indicators) according to the objectives of the edutainment sessions and the elements to be observed according to the points of view of the player and game designers (Annex 1).

The game session mobilizes different actors in the service of the design of a training device taking on distinct roles:

- The facilitator or “master of the game” presents the rules of the game, the organization of the session, encourages dialogue, animates, guides, maintains the atmosphere of the game and the debriefing phase.
- The players are active participants in the edutainment session.
- The observer is responsible for collecting data using the observation grid (Annex 1).

The players and the animator can also participate in the data collection through the evaluation sheet (Annex 2). Depending on the objective of the session and the human resources available, the roles of moderator and observer can be performed by the same person.

5.2 Experimentation Context

Wonder Vendeur has been tested within the Professional Training Institute 43, Apprentice Training Center in Haute-Loire (AURA Region). This training center has been active for more than thirty years and has been developing Information and Communication Technologies for ten years in the teaching and supervision of learners. The *Wonder Vendeur* experiment lasted 12 months, starting in September 2021. These observations relate to levels 3 and 4 of the sales - commerce - hairdressing sectors, with an average number of 15 learners per group, aged 16 to 25. . The total number of experiments is 41 learners (27 women and 14 men). Each Return of Experience allowed us to measure the commitment of the learners.

6 Results and Analysis

Feedback from experience has shown that the “traditional” phase of an educational session on the theme “The stages of the sales interview” is well perceived by all the learners (Appendix 2), we also note a good felt at the end of the session (61%) associated with a profit-sharing rate (73%). Learners have made the link with their professional activities and the session, but have difficulty memorizing the stages of the sales interview (37%) as well as the associated techniques (59%). They also express the complexity of reinvesting these skills in a professional context. Finally, by analyzing the results and following the debriefing phases, the learners tell us about their feelings about time: “time passes slowly sometimes” and this generates a certain form of weariness and boredom (73%). In comparison, the SG session reflects better results with positive feelings (88%) and interest in the session (98%). There are also differences in the notion of memorizing the stages of the sales interview (76%) and

associated techniques (71%). The latter transferred their teaching skills more easily to their professional activities (78%).

The first analyzes of the edutainment sessions show that the contextualization is more obvious, memorization is facilitated and that the approach is very well perceived by the learners. We notice almost unanimously that they have not, or very little, felt the effects of time during the edutainment session: “Is it already over?”, “Is it already...?” They also told us that they felt motivated and engaged throughout the game: “Can we do it again ?”.

The game mechanics used make it possible to make up for the “dead times” observed during “traditional lessons”. In addition, they verbalized and very quickly understood that we could learn in stimulating conditions: “we learn while having fun, it's great and in addition we all exchange together”. This SG approach also allowed some learners to assert their personality, others revealed themselves completely. During the experiments, we observed that the use of the SG facilitated the lifting of inhibitions: the learners let themselves be guided, carried by the mechanics of the game and a favorable work climate established by a feeling of fairness, of respect between players.

From the designer's perspective, we identify and emphasize the importance of agile design centered on player feedback, through iterative design loops, enabling strong learner buy-in to the game atmosphere (71%). We emphasize the importance of a design based on the “10 Commandments of SG Padawan” method [11] offering real support thanks to the key steps necessary to create and develop an engaging, motivating SG with a real pedagogical impact. Indeed, all the learners understood the rules of the game and 95% of the players appreciated the game mechanics used. In addition, we were surprised that a board game could generate so much support from a very technocentric Generation Z and Alpha: 83% of players appreciated the manipulation of cards, figurines and the roll of the dice.

Nevertheless, these results should be taken with caution, given the size of the panel of learners, they remain very encouraging and deserve to be verified on larger cohorts and to understand their levers more precisely (graphic universe, games, social interactions, use of several explicit or implicit memory anchoring techniques, etc.).

7 Conclusion

Indeed, our iterative design method of the design-based research type shows that the design phases of an SG articulated around the “10 commandments of SG Padawan” [11] and combined with the exploitation of traces (learners, designers) lead to an approach with measurable impacts on skills development and SG ownership. These two intertwined and simultaneous processes must be monitored and analyzed throughout an iterative design process. Through our experiments, we relate and demonstrate that it is an effective, efficient combination giving rise to a balanced SG with a strong membership rate and a unanimous rate of interest in the edutainment sessions. We also emphasize that this approach promotes motivation and commitment on the part of both learners and designers : each being at the heart of the whole process and players in this subtle balance.

In addition, the use of game mechanics allowed learners to develop transversal skills and we emphasize that the approach with an SG has a positive impact on creating and maintaining learners' motivation in learning knowledge and skills development. The comparative analysis between traditional courses and edutainment sessions highlights the commitment by placing active learners at the center of their training. Finally, it should be noted that the designed SG created team cohesion by valuing everyone's experiences, optimizing their potential under better conditions. This promotes the teacher-learner bond with interactions, moments of sharing. To strengthen and perpetuate this feeling of respect and belonging, each participating learner was able to integrate and share their professional experience by creating "Brand" and "Live my life" cards.

The future prospects of this collaborative design work by SG consist in further supporting a methodology by crossing perspectives between research, development/engineering, feedback from learners and teachers. The idea is to support designers more closely in all phases, to ensure a balance of forces to obtain a balanced SG consistent with the educational expectations of teachers and those of learners.

ANNEX 1

Objectives	Player View Observable non-verbal elements	Player view Observable verbal elements	Instructional designer Observable verbal elements
Promote knowledge transfer and learning	obs + pos : change of action performed by players in response to game mechanics and manipulation of artifacts (card board, etc.)	obs : assimilation and transfer of knowledge in relation to each item. obs : verification questions by players on the dynamics of the game and explanations provided.	obs : control of the assimilation of sales methods. obs + ind : Mastery of sales techniques. obs + ind : Transfer of skills in the professional context (company).
Express the values of the players (preferences, what they consider good or bad, fair or unfair, equitable, etc.)	obs : change in posture/mime/attitude obs : Sacred/superstitious reference gestures (blows on the dice before advancing, hands clasped before a question, eyes raised).	obs : sentences expressing value judgments, feelings in relation to his evolution on the board and the evolution of other players).	ind : assessment of the relevance of the questions and answers associated with each item.
Explore new individual/collective strategies.	obs+ act : new actions performed by players outside the rules of the game.	obs : verbalized proposals for new practices/strategies when negotiating or trying to destabilize other players.	obs : application of progression or regression mechanics. obs : follow-up of figurine customizations. obs + ind : follow the rules of the game. obs + pos + ind : monitoring the use of the game board.
Stimulate the emergence of new practices (new rules, variants, game mechanics, etc.)	obs : implementation of a legal or illegal non-verbal communication strategy.	obs : spontaneous request to create a collective. obs : transfer of resources between players. obs + act : relationships between individuals during the game.	obs : use of the playbook. obs + ind : understanding the rules at the start of the game and applying them during the session. obs + ind : management of miniature accessories.
Foster relationships between players.	obs : signs of empathy. obs : Appearance of new roles/positions in the game or in the group. obs : formation of groups favoring exchanges between players. obs + pos : learner proxemics. obs + pos : use of the different artefacts offered in the SG.	obs : sentences expressing group dynamics, power plays, and their opinions. obs : conflicts, tensions, collaborations, cooperations, solidarity, trust. obs + pos : emergence of leader, follower and disruptor.	obs + ind : quality of questions and relevance of bonuses/penalties. obs + ind : dimensions of the tray and accessories. obs + pos : layout of the play area, squares, accessories, etc.
Test, validate and improve the artifact.	obs : postures, gestures, mimicry, facial expressions, gaze reflecting interest or disinterest	obs : expressions of interest, disinterest obs : suggestions for improvements. obs : understanding brakes in the questions, the rules of the game. obs : link of transferability in a professional context. obs : request to continue or end the game. obs : asks to invite other people, groups/classes of learners to participate.	obs : item count. ind : distribution of game artifacts on the miniatures, on the board. obs + ind : number of slower progressing players.

Tab. 3. Grid for collecting traces

ANNEX 2

On a sample of 41 learners, we obtain the following results:

	Traditional approach					Gamified approach				
Evaluation criteria	1	2	3	4	5	1	2	3	4	5
Note the organization and conduct of the educational session	0%	7%	46%	39%	7%	0%	0%	15%	46%	5 ¹
Were the educational objectives clear?	0%	0%	24%	49%	27%	0%	0%	2%	88%	39%
Was the teaching content clear?	0%	0%	27%	54%	20%	0%	0%	5%	34%	10%
Rate the quality of teaching materials	0%	0%	24%	56%	20%	0%	0%	5%	56%	61%
Rate the animation of the educational session	0%	5%	7%	71%	17%	0%	0%	0%	59%	39%
Note the dynamism of the educational session (alternating theory/methodology/practice)	0%	2%	17%	63%	17%	0%	0%	2%	54%	41%
How do you feel at the end of the educational session?	0%	7%	32%	46%	15%	0%	0%	0%	7%	44%
I plan to reuse the elements learned during this educational session?	2%	5%	20%	41%	32%	0%	0%	12%	78%	93%
I memorized the stages of the sale?	2%	12%	22%	44%	20%	0%	0%	5%	61%	10%
I memorized the techniques of the sale?	5%	20%	34%	34%	7%	0%	0%	24%	49%	34%
Was I able to work independently during this session?	12%	17%	49%	15%	7%	0%	0%	29%	44%	27%
Was I able to work in a group during this session?	12%	15%	49%	17%	10%	0%	0%	0%	0%	27%
I felt like I was taking your time?	0%	10%	46%	20%	24%	41%	54%	5%	0%	100%

¹ Scale of 1 to 5: totally disagree to totally agree

I plan to reuse the concepts learned?	2%	15%	59%	20%	5%		0%	0%	44%	44%	0%
I have the feeling that I have understood the stages of the sale?	5%	7%	44%	27%	17%		0%	0%	10%	71%	17%
Did the educational session interest you?	0%	5%	22%	49%	24%		0%	0%	0%	0%	20%
Is the educational session related to your professional activity?	0%	0%	0%	5%	95%		0%	0%	2%	5%	100%
Did the class time go by faster?	2%	12%	59%	20%	5%		51%	5%	7%	2%	93%
I felt bored during this educational session?	0%	5%	73%	12%	10%		88%	7%	5%	0%	34%
In general, how would you rate the ergonomics of the board game?							0%	0%	5%	12%	56%
Is the game easy to install and understand the rules?							0%	0%	0%	0%	83%
Are the parts and trays easy to handle?							0%	0%	5%	17%	100%
Does the game offer enough variety to keep it interesting ?							0%	0%	0%	5%	78%
Are the game's artwork and graphics clear and attractive?							0%	0%	10%	19%	95%
Is the recommended number of players for the game right for your group?							0%	0%	0%	5%	71%

Tab. 3. Result of the traditional approach versus gamified approach

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