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Strengthening administrative knowledge through a serious game

fortaleciendo el conocimiento administrativo a través de una juego serio

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Abstract

Organizations are aware that knowledge is part of their competitive advantage. Continuous improvement of human resources within organizations is a policy of top management. Strengthening knowledge, reinforcing skills, and motivating employees fosters organizational ownership among both managers and subordinates. Workers aspire to specialize in a specific area to enhance their performance. Serious games are a modern tool that allows organizations to assist in training, reinforcing, and validating the knowledge they want to transfer to their employees. This article focuses on the design of a serious game based on previous knowledge from different organizational areas. Its purpose is to reinforce concepts and involve teamwork in choosing the best alternative to make decisions in various situations. This game was applied to a group of graduate students belonging to the Faculty of Mining at the National University of Colombia, and relevant conclusions are presented.

Keywords: Serious games; Administration; Decision-making; Knowledge.

Resumen

Actualmente, las organizaciones entienden que el conocimiento es ventaja competitiva, por esto, invierten en sistematización y protección adecuada, estas son conocedoras de que es el activo intangible más importante y costoso que tienen. El recurso humano dentro de las organizaciones juega un papel muy importante, porque son

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estos los que dieron origen a la creación, desarrollo y transformación del conocimiento, es notorio el interés de los trabajadores por dominar el conocimiento de un área específica, porque saben que este les dará el dominio sobre las demás áreas empresariales que dependan de ella. Este artículo se centra en el diseño de un juego serio basado en conocimiento previo de las diferentes áreas organizacionales con el fin de reforzar conceptos, involucrando el trabajo en equipo en la elección de la mejor alternativa para tomar una decisión a diferentes situaciones planteadas. Posteriormente este juego será aplicado a un grupo de estudiantes de posgrado pertenecientes a la Facultad de Minas de la Universidad Nacional de Colombia y se presentarán las conclusiones pertinentes.

Palabras Clave: Juego serio; Conocimiento; Toma de decisiones; Organización.

1. Introduction

The constant change and competitive dynamics of today's world compel organizations and their executives to leverage strengths and opportunities to confront and overcome threats, challenges, and difficulties. To fulfill this task, managers of different areas must concentrate their efforts and attention on acquiring and mastering knowledge in their respective domains.

There are two types of knowledge: explicit and tacit. Explicit knowledge is structured, stored, and distributable. This information it's found in programs, manuals, tutorials, and databases. It is easy to communicate and share among individuals. On the other hand, tacit knowledge cannot be stored, structured, or distributed since it results from experiences and learning. It encompasses customs, values, perspectives, and intuition, among others. Tacit knowledge is said to reside at an unconscious level and manifests when required. It is characterized by being personal, difficult to explain and communicate.

Serious games are understood as games designed to achieve one or several objectives based on knowledge acquisition or skill development (Matas, 2015). Abt (1987) introduced the first formal definition, stating that serious games are explicitly and intentionally designed for educational purposes rather than primarily for entertainment. It also emphasized that this does not imply that serious games should not be enjoyable.

This study aims to analyze the relationship between serious games, knowledge, and the scenarios individuals face in their daily lives, aiming to develop useful skills in the workplace. Recognizing the need for executives to learn, master, and reinforce topics related to the business areas in which they operate and make daily decisions, the game's design serves as a means to accomplish this objective. Additionally, it aims to create an environment where teams can share their explicit and tacit knowledge to respond correctly to the questions and situations presented in the game.

2. Theoretical framework

We present a theoretical review that connects knowledge and experiences in different business areas, teamwork, and decision-making with the implementation of serious games as an educational tool and the development of abilities.

2.1. Knowledge and Business Experiences

Knowledge is the mental existence of ideas about a thing or things. It comprises mental models, ideas, and learning. Additionally, it is a fluid combination of textual information, values, expert acumen, and experience that serves as a reference for evaluating and assimilating new information and experiences (Fuente *et al.*, 2002).

Personal intellectual capital shapes knowledge. It is acquired, stored, interpreted, applied, maintained, and improved through an ongoing process of evolution and change within each individual. When knowledge is shared within a group and subjected to the processes of application and transformation, it becomes applicable and functional (Rojas Mesa, 2006).

In organizations, knowledge is not only found in documents but also in processes, procedures, routines, norms, and practices. It is closely associated with the concept of experience, particularly in relation to formal or informal learning processes (Sánchez Fuente *et al.*, 2002).

Ultimately, knowledge is regarded as "an intangible business resource necessary

for the development of organizational activities, both at the individual and group levels. It provides individuals with the ability to interpret realities, situations, and phenomena" (Sánchez Fuente *et al.*, 2002).

The areas of the organization are as follows:

2.1.1. Management Area. The management area is responsible for setting goals and directing the organization. It is commonly associated with the head of the business. The functions of this area revolve around planning the way forward, ensuring that goals are not deviated from, and organizing and coordinating the other areas. In summary, the principal task of this area is to contribute to the success of an organization (Gestion.org, 2020).

2.1.2. Production Area. The production area in organizations is responsible for transforming supplies into finished products or services. It encompasses activities such as quality control, inventory management, machine design, maintenance, and repair, as well as the utilization of necessary tools for production (Chao González, 2020).

2.1.3. Marketing Area. The marketing area "focuses on identifying customer needs and satisfying them through an in-depth understanding of the client. It aims to tailor products or services to meet those needs". Marketing is defined as a "social and administrative process through which groups and individuals exchange goods and services to fulfill their needs" (Chao González, 2020).

2.1.4. Finance Area. Every organization requires a finance area to make decisions that increase equity and ensure proper administration and investment of resources, leading to economic performance. The purpose of this area is to obtain liquidity and profitability, thus preventing the organization from facing insolvency. It is crucial to avoid wasting time, money, and resources (Chao González, 2020).

2.1.5. Human Resources Area. The human resources area, also known as "human capital," is responsible for helping employees achieve their personal goals while aligning with the organizational objectives.

It includes tasks related to employee welfare, recruitment, selection, hiring, onboarding, payroll, career planning, and layoffs (Chao González, 2020).

2.1.6. Research and Development and Innovation Area (R+D+i). The primary function of an R+D+i department is to search for services or products that improve various aspects of the organization and provide a competitive advantage. This area focuses on "developing new technologies that facilitate the organization's work, optimizing processes, and gaining extensive knowledge about the product or sector, competition, and the market". The goal is to reinvent the business and achieve higher profits at all levels (Incotec - Innovación Eficiente, 2020).

2.2. Teamwork

Teamwork is considered a competitive advantage and a determining factor in today's work environment. Its importance has led to a change in the way work is approached, resulting in an increase in the use of work teams. This collaborative approach fosters job satisfaction, innovation, and productivity. (Torelles *et al.*, 2011).

Teamwork involves the collective effort of individuals, leading to performance superior to the sum of individual contributions. Roles within a team work together towards a common objective. Successful teams are characterized by a team spirit based on trust, mutual respect, and kindness. Creating and managing a team goes beyond simply bringing people together; it requires considering the technical skills, knowledge, and experience of individuals and ensuring that they can coordinate actions based on their personalities, and as a team, they will take the correct decisions (Torelles *et al.*, 2011).

2.3. Decision Making

Decision-making is a "comprehensive process that involves evaluating alternatives and making judgments to choose one among them". It encompasses analysis, categorization, probabilistic judgments, construction of alternatives, and ultimately reaching a

decision (Salinas and Rodríguez, 2011). Decision-making is a continuous process in everyday life, “within organizations, decisions are taken primarily carried out by first and second-level managers, entrepreneurs who play influential, outstanding, and decisive roles in the organization, looking to create, build and change organizations through their actions” (Vélez, 2007).

We will consider three definitions of decision-making. According to Chiavenato (2007), “Decision-making is the process of analyzing and selecting among various alternatives to determine a course of action”. Certo (2001) defines decision-making as “choosing the best alternative to achieve objectives based on probability”. Thus, decision-making involves selecting the optimal option among various alternatives through an analysis process that employs techniques and pursues a common goal. According to Rodríguez (2015), “decision-making is an informational process in which individuals and groups, based on an organization’s objectives and strategies, identify the best decision and course of action to effectively solve a problem, exploit an opportunity, or manage institutional risks”.

Making good decisions relies on having the necessary information, and although there is always an element of risk, collecting relevant data can help mitigate it. Ultimately, the decision-maker, drawing on sound judgment, experience, knowledge, intelligence, education, and available time, determines when to stop collecting information and choose the most appropriate course of action (Solano, 2013).

3. Design methodology

To design a serious game that strengthens areas of business knowledge, we will utilize the methodology developed by Gómez (2010), which consists of ten steps described below:

3.1. Identify the theme of the game

One of the fundamental aspects in an organization is its members, who spend the majority of their time within it and enable its proper development through organized

activities. Business management involves critically analyzing the necessary strategies to adapt to changes in the environment, market, and society. Executives with a high level of tactical and strategic expertise carry out this activity, requiring constant development of skills and business knowledge to face situations and achieve organizational goals (Camacaro, 2017).

The game’s theme focuses on evaluating and strengthening knowledge in six business areas: management, production, marketing, finance, HR, and R&D&I.

3.2. Define the purpose of the game

The main purpose of the game is to evaluate knowledge in the functional areas of an organization. To achieve this purpose, the following steps must be followed:

- Build a scenario where knowledge in the business areas is crucial for progress in the game.
- Present different alternatives for making accurate decisions, using the game as a didactic environment.
- Provide a competitive setting where teamwork is important to win the game.
- Encourage interaction and the sharing of experiences among participants, through different perspectives built from personal experiences.

3.3. Establish the instructional objectives of the game

- The instructional objectives of the game are as follows:
- Evaluate the business knowledge of each team.
- Strengthen teamwork among the members for decision-making.
- Identify the most developed areas of business knowledge in each team, based on their preferences and academic-work activities.

Reinforce and develop knowledge in various areas such as management,

production, marketing, finance, HR, and R&D&I.

3.4. Identify and define the general concepts of the theme

At this point, certain necessary steps must be followed to address the theme of the game:

- Provide a general description of the theme.
- Enumerate the basic concepts that constitute the theme.
- Define each of the enumerated concepts.

The general concepts of the game's theme are knowledge in business areas (management, production, marketing, finance, HR, R&D&I), teamwork, and decision-making. These concepts are described in the theoretical framework.

3.5. Select candidate techniques

According to Gómez (2010), "Based on the concepts and definitions gathered in the previous step, a set of candidate game techniques can be established to transform the theme of interest into a game format".

To select a set of candidate techniques, it is necessary to search for keywords (selected by the client or interested party) that encompass the three previous elements of the game in the design process: the theme's name, instructional objectives, and definition of concepts, within all the keywords of the different techniques in the knowledge base of the method (Gómez, 2010).

The keywords highlighted by the interested client for each item are:

Theme name: game, representation, bank, questions, situations, knowledge, areas, functional, organization, management, production, marketing, finance, HR, research, development, innovation.

Instructional objectives: learn concepts, possible situations, areas, games, reinforce, enhance, identify, develop, teamwork, participants, skills, decision-making.

Basic concepts and definitions: knowledge, experiences, business,

management, production, marketing, finance, HR, research, development, innovation, teamwork, and decision-making.

If any of the words highlighted by the client in any of these 3 items match a keyword of any technique, that technique is considered a candidate technique and will be included in the next step of the method (Gómez, 2010).

3.6. Select the most appropriate technique(s) based on the characterization of the theme

Once the candidate techniques have been selected (Appendix A), characterization questions with assigned scores are conducted. The final result of the survey should be divided by the maximum possible score, and the results are analyzed according to the following criteria:

Criterion 1: If the quotient between the obtained score and the maximum score is greater than or equal to 0.85 for a candidate technique, that technique is considered the most suitable for incorporating the characteristics of the game (Gómez, 2010).

Criterion 2: If the quotient between the obtained score and the maximum score falls between 0.7 and 0.85 for one or more candidate techniques, all techniques whose obtained score/maximum score ratio falls within that range are considered the most appropriate technique(s) (Gómez, 2010).

3.7. Incorporate specific knowledge into the game

Once the suggested technique is selected, the technical template is modified. This template includes basic elements such as game rules, necessary materials, and the number of participants. Additionally, the concepts to be addressed in the game are added (Gómez, 2010).

Moreover, this game template includes elements specific to the educational purpose, such as the game's purpose, instructional objectives previously established during the design process, the theme's name, and the enumeration of basic concepts related to the theme (Gómez, 2010) (Appendix B).

Figure 1. End game design

Source: Authors' own elaboration.

3.8. Develop pilot sessions of the game

The pilot sessions of the game were conducted virtually due to the current health conditions, and the participation of the administrative team of TransporTempo SAS. It is important to note that, due to the dynamic nature of the game, only a review of the automated question generation template was conducted to correct any errors in the execution and wording of the different questions to enhance their comprehensibility.

3.9. Consolidate the game

The final presentation of the game was conducted with postgraduate students from the Universidad Nacional de Colombia, Medellín Campus (Figure 1).

4. Results

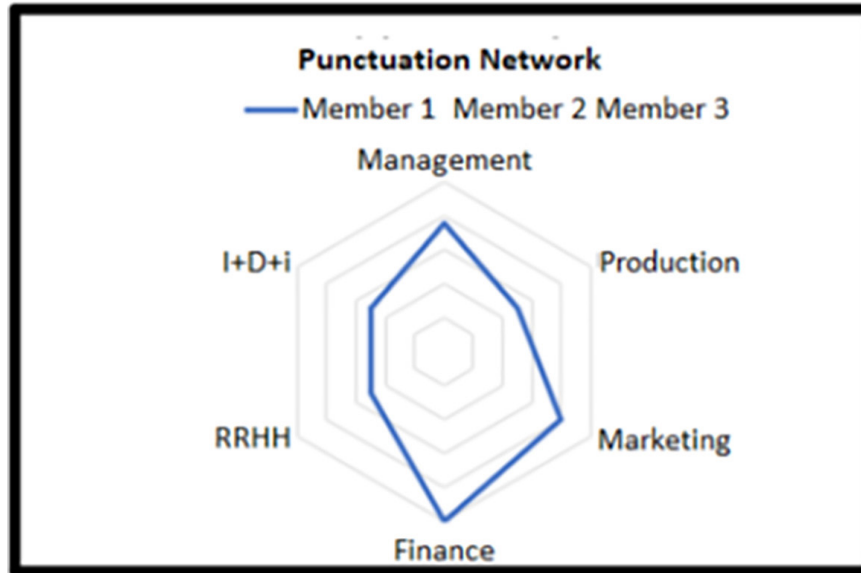
After the pilot test focused on reviewing the automation of the template containing the questions and answers for each area

of the game, which was carried out at TransporTempo SAS, some errors were perfected in the execution, and the wording of different questions was modified to achieve better understanding and interpretation of the given situation based on engineers' suggestions. Additionally, modifications were made by the instructor to enhance the game.

Finally, the game was executed with postgraduate students from the National University of Colombia, Medellín Campus. The following are the results obtained from this exercise:

In Figure 2, the results obtained by Team 1, composed solely of male postgraduate students, are shown:

As observed in Figure 2, this team has strong foundations in the finance area, suggesting that men may develop certain skills that enhance decision-making when financial resources are involved. This is because the team members work in financial organizations, which reinforces their knowledge. However, it is important

Figure 2. Team 1 results

Source: Authors' own elaboration.

to highlight that the management and marketing areas are second in their score within the network scheme, indicating the type of tactical and strategic decisions they make in their work activities.

Lastly, the weakest areas for this team are HR, production, and R&D&I, as they are not closely related to their interests in the academic and professional fields. Team 1 achieved an overall score of 68%.

In Figure 3, the results of Team 2, also composed of male postgraduate students, are shown:

In Figure 3, it can be observed that this team is inclined towards the finance area, confirming the assumption made with Team 1. However, it is important to note that the results for the production area are not evaluable in this case, as there were no questions presented in the game to measure it. Additionally, based on the work and academic activities of the team members, strengths in the HR and R&D&I areas can be determined, where men usually do not achieve outstanding scores.

The weak area for this team is marketing because their interest does not lie within this area of the organization. However, the management area has opportunities for

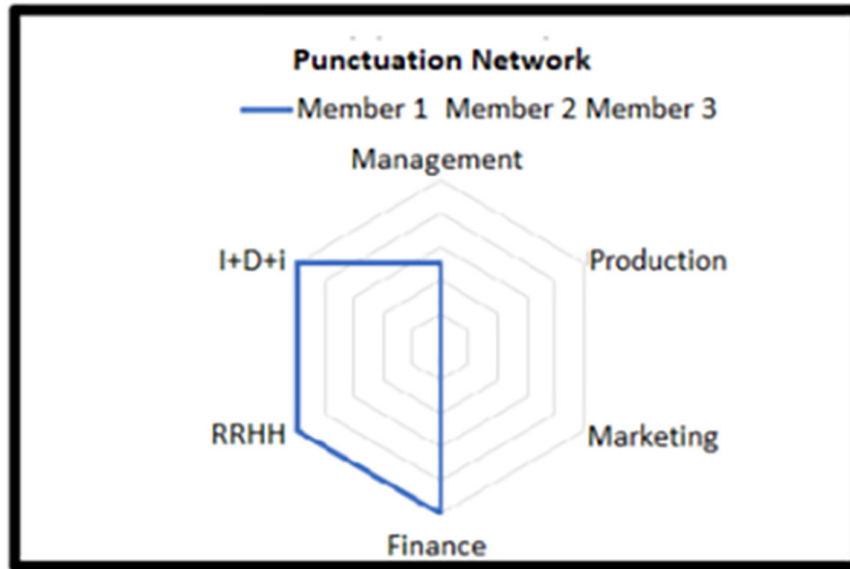
improvement, which are addressed through tactical and strategic decision-making to achieve a better interpretation of complex situations. Team 2 achieved an overall score of 70%.

In Figure 4, the results of Team 3, also composed of male postgraduate students, are shown:

Figure 4 shows that Team 3 is inclined towards the management, production, and marketing areas, as the two team members have work experience and develop competencies in these business areas. However, it is important to note that the results for the R&D&I area are not evaluable in this case, as there were no questions presented in the game to measure it. In this case, the finance area does not have the same impact as Teams 1 and 2, despite also being composed of male members. This may be due to the lack of complementarity in decision-making discussions when one team member is absent. However, it is the second area with the highest score within the network scheme.

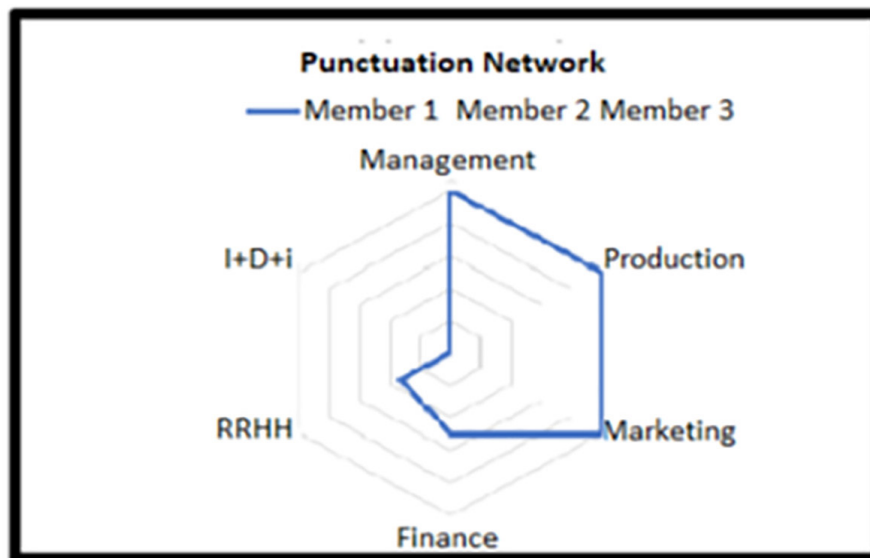
The weak area for this team is HR because their interest and experience do not lie within the activities related to this area of the organization. Team 3 achieved an overall score of 77%.

Figure 3. Team 2 results



Source: Authors' own elaboration.

Figure 4. Team 3 results



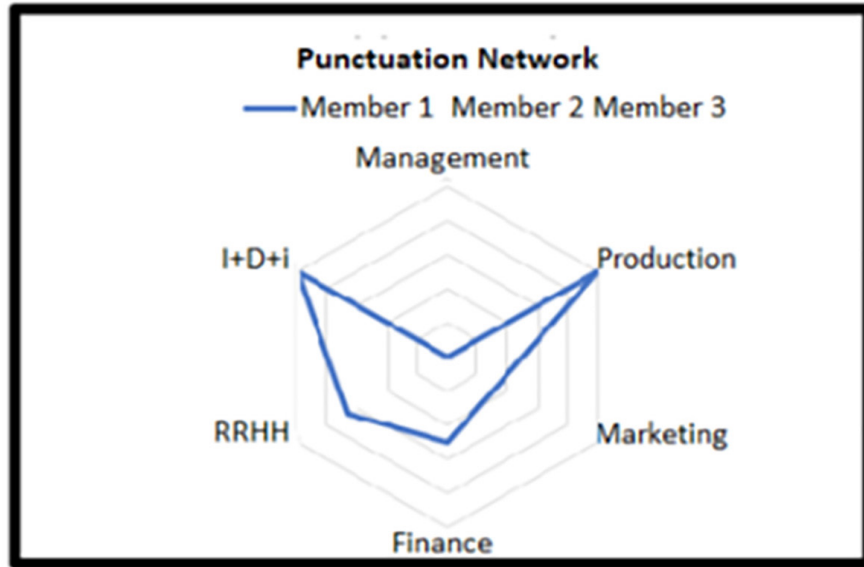
Source: Authors' own elaboration.

In Figure 5, the results obtained by Team 4, composed solely of female postgraduate students, are shown:

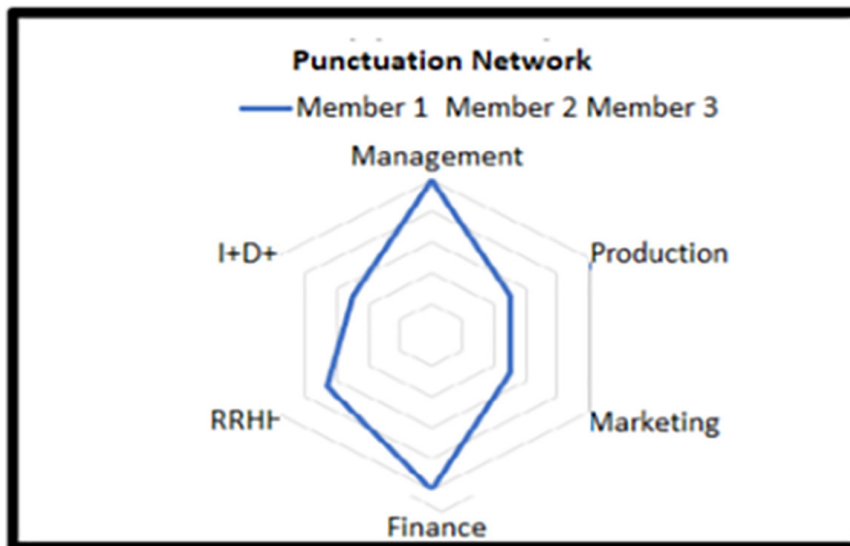
As observed in Figure 5, Team 4 has strengths in the production and R&D&I areas, as the team members develop and enhance knowledge in similar areas within important organizations in Colombia. In this

case, the areas of HR, finance, and marketing are at an intermediate level, respectively, as women tend to possess more comprehensive profiles than men.

The area to work on for this team is management because, according to the Foundation for Applied Economic Studies (FEDEA), women occupy only 10% of senior

Figure 5. Team 4 results

Source: Authors' own elaboration.

Figure 6. Team 5 results

Source: Authors' own elaboration.

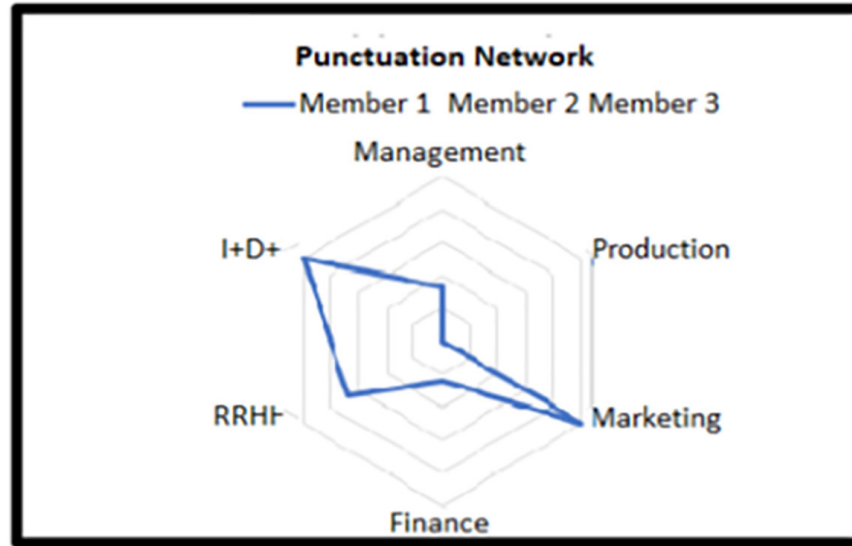
management positions, which means they do not commonly encounter situations of this nature in their daily work experiences. However, according to Monique Leroux in Forbes Mexico (2015), an increase in the number of women in boards of directors has positive effects on management quality, including risk management. In fact, the presence of women influences

decision-making by providing a diversity of perspectives that determine success. Team 4 achieved an overall score of 58%.

In Figure 6, the results obtained by Team 5, also composed solely of female postgraduate students, are shown:

In Figure 6, it can be observed that this team specializes in the finance and

Figure 7. Team 6 results



Source: Authors' own elaboration.

management areas because women have a greater participation in decision-making within the organizations they currently work in. Additionally, the other areas are homogenous within the scheme, with a slight increase in HR, which suggests the comprehensive knowledge these women possess due to their work and academic activities.

The weak area for this team is not easily identifiable due to the aforementioned reasons. However, the production, marketing, and R&D&I areas have lower scores and can be strengthened through participation in organizational decisions or specific studies. Team 5 achieved an overall score of 69%.

In Figure 7, the results obtained by Mixed Team 6, composed of 2 female and 1 male postgraduate students, are shown:

Figure 7 shows that Team 6 has strengths in the marketing and R&D&I areas, as the team members have affinity and interest in these areas based on their work activities. The network scheme represents an arrow directed towards R&D&I with the tip in marketing and shows moderate knowledge in the HR and management areas, allowing them to perform well in their current positions. The women in this team try to balance the network with the comprehensiveness they

possess from their studies and experiences.

The weak area for this team is production because none of the team members have dealt with issues of this nature in their work experience or specialized studies. Team 6 achieved an overall score of 54%.

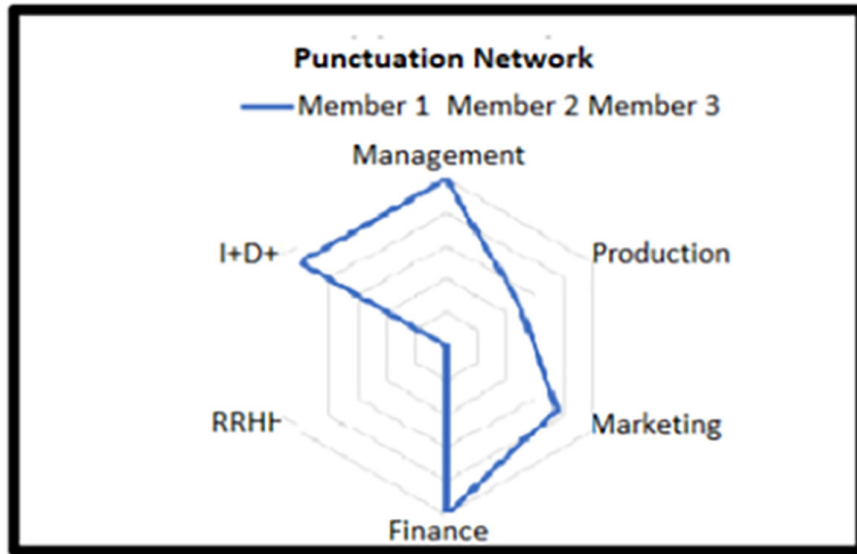
In Figure 8, the results obtained by Mixed Team 7, composed of 2 female and 1 male postgraduate students, are shown:

As observed in Figure 8, Team 7 has three more developed areas: management, finance, and R&D&I, as the team members engage in tasks related to these areas. In this case, the marketing and production areas are at an intermediate level, respectively, based on the knowledge they have acquired throughout their academic and professional journey.

The area to work on for this team is HR, as they lack experience in this field and it does not generate interest among the team members. Team 7 achieved an overall score of 71%.

5. Conclusions

Based on the game, it can be concluded that business knowledge is a prerequisite for success in a work environment. Furthermore, it facilitates the improvement

Figure 8. Team 7 results

Source: Authors' own elaboration.

of decision-making skills, including active listening, understanding and supporting others' ideas, and executing them. This game highlights the significance of active participation from all team members, who utilize their skills and knowledge to reach accurate answers and establish a well-balanced network scheme across different areas of the organization.

Through the game's development, it becomes evident that teams working in various organizations on a daily basis have greater potential to contribute knowledge and previous experiences. This synergy enhances performance during the game and fosters a dynamic teamwork environment, where aspects like respect and listening to others' arguments easily lead to effective problem-solving.

As the game progresses, leaders emerge within teams, assuming the roles of guides and facilitators during the decision-making process. Other team members unite their skills and abilities under their guidance to pursue optimal solutions. Teams with effective leaders tend to achieve better performance, emphasizing the importance of leadership in teamwork.

This particular game and the broader context of serious games showcase how

dynamic gameplay incorporating knowledge and previous experiences can foster the development of non-technical skills and knowledge, particularly teamwork. Throughout the game, participants actively contribute their skills, knowledge, and tools to achieve a common objective. Moreover, teams that successfully leverage individual capacities demonstrate superior performance, surpassing the goals initially outlined in the game instructions.

6. Conflict of interest

The authors declare no conflict of interest.

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Annex A. Keywords

Settlers of Catan	Keywords: Resources, Raw Materials, Random, Probability, Strategic Plan, Events
Monopoly	Keywords: Negotiation, Resources, Chance, Properties, Investment, Events.

Source: Authors' own elaboration.

Annex B. Technical template

I. Generalities

Technical name	Strengthening administrative knowledge through a serious game (combination of two techniques: The Settlers of Catan and Monopoly).
The objective of the game	Games' objective is to correctly answer the questions referring to the different business areas to advance on the board and reach the end of it.
Number of players	Maximum 3 teams per board, each made up of 2 or 3 players.

II. Educational component

Name of the technique	Knowledge in business areas.
Purpose	Create a scenario where knowledge in business areas is essential to advance in the game. Present different alternatives for making the right decisions through a didactic environment. Provide a competitive arena, where teamwork is important to win the game. Socialize experiences through interaction with other participants and their different points of view built from their experiences.
Instructional objectives	Assess the business knowledge of each team. Promote teamwork among members to make decisions under pressure. Identify in each team which is the most developed areas of business knowledge according to preferences and academic-work activities. Strengthen, learn, and develop knowledge in different areas such as management, production, marketing, finance, HR and R+D+i.
Subject Basic concepts	Knowledge, business experiences. Management, production, marketing, finance, and human resources area. Research, development, teamwork, and decision-making.

III. Materials

Name	Quantity	Description
Board	3	It contains the design of a ladder game with boxes from 1 to 70. Each box with a convention established for each of the areas of the company and the extra bonus. And contains stairs and slides.
Chronometer	3 (one per board)	To measure time to answer the question.
Records	7 (one per team)	They represent each of the game teams.
Dices	3 (one per board)	They show the number of spaces that the team advances in each play (1-6).
Computer	7 (one per team)	When employing an Excel template that contains the bank of questions, the random question. The template shows whether the question is correct or not, and will show the random bonuses.

IV. Game rules	
Num.	Description
1	Maximum 3 teams per board where 2 to 3 pieces play. Each token represents 3 players.
2	The developers of the game will make the teams.
3	In the beginning, each team chooses the color of the card that they like the most. Each team rolls the die, and the team with the highest number advances first, followed by the team to the right. In the corresponding turn, the die is thrown and the number of boxes corresponding to the number that came out on the die is advanced, following the numerical order on the board.
4	When landing on a square where a ladder begins, it goes up to the square where it ends. Stairs only go from bottom to top.
5	When landing on a square where the start of a slide is, you must slide to the square where it ends. The squares through which the stairs and slides pass, which are neither the beginning nor the end of any, do not lead up or down.
6	When landing on a box with one of these letters, each team must answer a random question according to the indicated letter. G: management, P: production, M: marketing, H: human resources, I: I+D+i. If you answer the question correctly you will be able to continue advancing in the game until you fail in the answer. Each team has a maximum of 30 seconds to respond, if they do not respond within the established time, they will lose their turn.
7	When landing on a box with the letter B you will get a bonus (this can benefit or affect), and the bonuses will come out randomly.
V. Winner selection criteria	
To reach the last square (70) it is necessary, on the die, the exact number of squares that are missing, if the team obtains more or less, it must wait for the next turn. Upon reaching this box a question will be asked, if you answer correctly, you will win the game.	
Note: If after 40 min, no team has reached square 70, the team that has advanced the most will win the game.	
Source: Recovered from Gómez, (2010).	