Field mat as a teamwork arena: the narrative space of robotics games

Tapete de campo como arena para trabalho em equipe: o espaço narrativo dos jogos de robótica

Alex Paiva

Ph.D. in Design at Universidade Federal do Paraná
paiva.alex9@gmail.com

Luciane Maria Fadel

Ph.D. in Typography and Graphic Communication at The University of Reading
liefadel@gmail.com

ABSTRACT

This paper investigates the development of a design object called Logistics Field Mat and how its narrative space can create a collaborative game environment. It followed the Design Science Research (DSR) approach and Peffers' protocol to identify a problem, develop a design object, demonstrate its potential, evaluate and apply it to five robotics games, and communicate the findings. The results indicate a narrative space generated by the mat composed of a well-defined setting, a spatial structure, a story space, a narrative world, and a universe that can foster player engagement by positioning the field mat as an educational tool. Furthermore, the mat remediates two media: game boards and maps. This remediation highlights the narrative space and transforms it into a meaningful space.
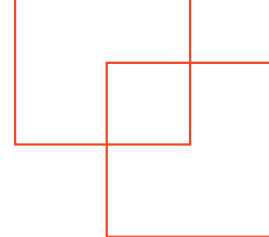
KEYWORDS

Field mat, robotics, Design Science Research, FIRST LEGO League, Close Reading

RESUMO

Este trabalho investigou o desenvolvimento de um objeto de design denominado Tapete de Campo de Logística e como seu espaço narrativo pode criar um ambiente de jogo colaborativo. Parta tanto, seguiu a abordagem de Design Science Research (DSR) e do protocolo de Peffers para identificar um problema, desenvolver um objeto de design, demonstrar seu potencial, avaliar e aplicá-lo em 5 jogos de robótica e demonstrar os benefícios desse processo. Os resultados indicam um espaço narrativo gerado pelo tapete composto pela combinação de um cenário bem definido, uma estrutura espacial, um espaço de história, um mundo narrativo e um universo que juntos podem fomentar o engajamento por parte do jogador posicionando o tapete como uma ferramenta educacional. Além disso, o tapete remedia duas mídias: tabuleiros de jogo e mapas. Esta remediação destaca o espaço narrativo e o transforma em um espaço significativo.

PALAVRAS-CHAVE

Tapete de Campo, robótica, Design Science Research, FIRST LEGO League, Close Reading

INTRODUCTION

FIRST (For Inspiration and Recognition of Science and Technology) aims to inspire young people to be leaders and innovators in the world of Science and Technology. Founded in 1989, FIRST creates innovative programs to motivate young people to stay in school and pursue career opportunities linked to science, technology, engineering, and mathematics by building self-confidence, knowledge, and life skills (FLOWERS, 2022).

Although many studies led by FIRST focus on children's academic performance, there is little information about how field mats can influence, encourage, motivate, and impact its users. Therefore, these mats have been considered neither a narrative space that creates an immersive experience for players nor the center of a playful activity capable of arising, among other things, the pleasure of learning.

Thus, the objective of this paper is to demonstrate that field mats have the potential to create a playful environment by generating fun and fostering concentration. In order to do that, this paper describes the development of an original mat using a Design Science Research (DSR) approach and its application in a series of corporate workshops for training leaders from different companies in Brazil.
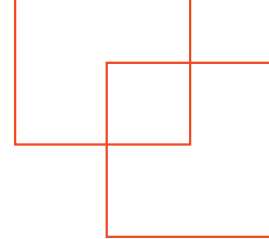
The paper begins with a brief review of remediated media, such as maps, game boards, and narrative spaces. Then presents the research method and the development and analysis of the field mat. Follows a questionnaire that evaluates the relevance of the field mat activities and possible considerations.

2 LITERATURE REVIEW

2.1 Maps

Maps are cultural texts that represent a set of codes (HARLEY, 2009). Thinking about a map brings to mind an image of a scientific representation of a real space with reliable certification for the reader (EDNEY, 1995).

According to Norcia (2019), the history of maps dates back to the

ancient civilizations of the Sumerians in 2500 BCE. The Sumerians developed the first formalized written language to document and transmit their geographical knowledge and create the first known map. The Greeks and Romans followed, producing maps of their known world. However, the first detailed maps were not completed until the Middle Ages. Each map created distortions to function as a readable text so that a nonfictional environment could fit into a media medium.
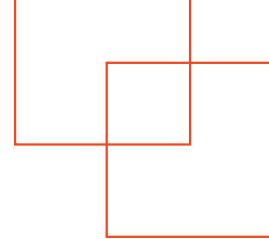
Although the strategy of distortions persists until the present day, it was during the 16th and 17th centuries that maps became more detailed and accurate, aided by advances in surveying, mathematics, and printing technology. By the 19th century, maps were created and printed on a mass scale, with detailed topographic and geological surveys.

Cartographic productions were instruments of power over territories and the people who inhabited them. According to Norcia (2019), maps did more than point out the location of mountains, the length of the sea coast, or the positioning of cities. Maps imply subliminal messages such as ideology, beliefs, and practices (NORCIA, 2019).

2.2 Game boards

Game boards have been around for more than 5000 years. Ancient game boards carved in stones are present in different places around the world (SCHÄDLER, 1995; SHIMIZU e MIYAHARA, 2002; SIMPSON, 2007; UBERTI, 2012), such as in India (chess game), Egypt (game of Morris and Game of Mehen), China (game of Go), Mesopotamia or Iraq (royal game of Ur and Checkers), and Persia or Iran (Backgammon). The Senet game, discovered in ancient Egypt, was the oldest. Its game board was found in Pre-Dynasty burial chambers and First Dynasty tombs dating back to 3,500 BCE (PICCIONE, 2007). In the Middle Ages, game boards were used for various purposes. They were played on bases that were often elaborately decorated pieces of art. Additionally, game boards served as educational tools and maps illustrating medieval geography.

The industrial revolution of the 19th century saw the proliferation of games printed with complex patterns. According to Norcia (2019), the

first commercial game boards were hand-colored sheets printed on copper plates cut into squares, and glued onto linen cloth for easy folding and storage of the pieces.

In summary, a game board is usually a detailed map of something like a country, a city, sometimes a building plan, a dungeon, or a cave that is represented on media that can be placed on a table (SELINKER, 2011).

2.3 Field mats

Field mats are large, vinyl playing mats made for the FIRST LEGO League and FIRST Tech Challenge robotics competitions. The mats create a playing area and help ensure a fair and consistent field for teams to compete on.

Seshan and Seshan (2020) explain that the field mat is considered the main component of the competition equipment in the FIRST LEGO League. The mat elements include elaborated images, circles, square-shaped areas, and grid pattern lines. According to Kelly (2012), black lines can be part of the scene and, at the same time, serve as a guide for the light sensor to guide the robot across the surface. In summary, Seshan and Seshan (2020) and Magpili (2020) agree that field mats are a themed playing field prepared for a robotics competition where the robots move and follow the game rules.

In 2020, the FLL Challenge involved over 318,000 students, working in 38,600 teams in approximately 110 countries, making it one of the world's largest educational robotics competitions (FIRST, 2020).

2.4 Narrative spaces

Narrative spaces are essential for creating a cohesive experience for viewers or players, as it allows them to become immersed in the world and the narrative provided by the media. Narrative spaces are areas in a media product that contain elements that create a narrative experience. These spaces can include objects, scenes, sounds, music, dialogues, or other components used to convey a story. Tapscott et al. (2013) define narrative spaces as "information spaces that ground all media based on characters, situations, plots, and other entities." Ryan (2014) describes five categories that form a broader perspective on a
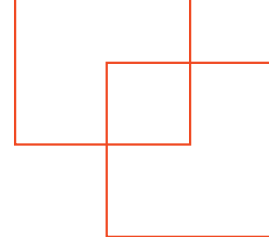
narrative space: the setting, spatial structure, story space, narrative world (or story), and narrative universe.

In games, narrative spaces are important for allowing players to explore and become immersed in the game world while still advancing the narrative. Narrative spaces often involve establishing situations that introduce players to the story's setting. The space used as a narrative set in a game is critical in generating an entertaining user experience, as it builds meaning and brings a sense of immersion to players (YIANNOUTSOU, 2010). Hirvonen and Igareda (2017) started their view of **setting** as the physical, inanimate environment or place in which the narrated action took place and expanded the meaning to a material, inanimate place of action having constitutive objects and entities (or things that become constitutive or identifiable with that setting) as well as different levels that have multiple layers and dimensions in which the action takes place. For Hirvonen and Igareda (2017), a car initially seen as an object in the scene can become the setting or a place of action at another point in the narrative. Ryan (2014) goes further and argues that the setting cannot be described only by the existing physical environment but has to be expanded to the overall socio-historical-geographical environment in which the action takes place.

Spatial frames are identified by Ryan (2014) as another element that constructs a narrative space. For her, a spatial structure is the immediate surroundings of actual events that can change scenes in action and flow into each other. They are organized hierarchically by containment relationships, and their boundaries can be clear or undefined (RYAN, 2014). The notion of boundary is a critical referential element in constructing an articulated and realistic environment. It was one of the first principles by which early civilizations identified their space as their world (INSIDE-OUT, 2015).

The **story space** consists of the spatial structures and all the locations mentioned by the text, not the actual setting where the events took place. The story space is a combination of all spaces relevant to the plot, including those mapped by the characters' actions and thoughts (RYAN, 2014).

The **narrative world** is the story space supplemented by the reader's
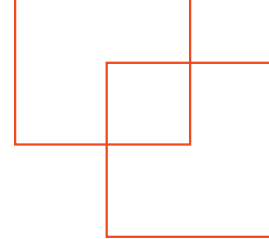
imagination based on cultural knowledge and real-world experience (RYAN, 2014).

The **narrative universe** incorporates not only the spatio-temporal characteristics of a world but also all the psychological characteristics that the characters carry with them (RYAN, 2014). Concepcion et al. (2017) summarize the narrative universe as the world (in the spatio-temporal sense of the term) presented as real by the text, plus all the counter-factual worlds constructed by the characters such as beliefs, desires, fears, speculations, hypothetical thoughts, dreams, and fantasies."

Ruotsalainen (2015) states that in a play environment, play extends beyond spatial structures to both space and temporal extent, creating a narrative space. The spatial structure intersects with many other layers, such as the willingness and predisposition to engage in a narrative universe. This intrinsic motivation of wanting to enter a state of total immersion is a characteristic of activities that can lead a person into a state of flow (CSIKSZENTMIHALYI, 1990).

3 METHODOLOGY

This study followed the Design Science Research (DSR) approach. The DSR process is a framework used to develop new approaches to information system problems. Stuart Card and colleagues developed it at Xerox's Palo Alto Research Center (PARC) in the 1980s. According to Manson (2006), artifact development is an essentially creative process analogous to the theorizing process present in the natural sciences, in which different researchers can generate independent theories for an equal set of observations (MANSON, 2006). Therefore, this process can be considered relatively subjective and difficult to standardize. However, protocols are recommended when creating and analyzing the designed object.

This research applied the protocol developed by Peffers et al. (2008), which involves the following steps.

(1) Identifying the Problem and Motivation where the research problem is created along with a justification of the solution's value.

In the introduction of this paper, the CaRS model was used to establish the research space. According to Meyer (2009), the model
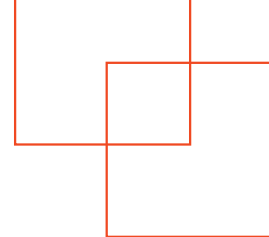
consists of three movements: (1) establish a territory); (2) locate where the research niche is established; and (3) occupy this niche. These moves were used to make the research problem and motivation, establishing relevance for creating the project object.

(2) Objectives of the Solution and the Design and Development are detailed in Section 4 of this article which describes the construction of two prototypes of the Logistics Field Mat that a solution.

(3) The demonstration is the stage where the Close Reading method was used to analyze the field mat object in detail. According to Bizzocchi and Tanenbaum (2011), Close Reading is a detailed examination, deconstruction, and analysis of a media type.

The first step of the analysis, or the "first reading," was aimed at observing the general structure of the artifact, emphasizing the main graphic elements. In this step, the field mat was read a few times, and a review of the artifact was constructed in a spreadsheet table format to demonstrate its relevance. The central theme of the mat was identified, and all the key elements that represented it were included in the table. Then the main areas of the mat were mapped/listed and divided into action areas or simple graphic elements that validate the central theme.

The second reading was based on the list of action areas and on the analysis of the screenshots of each of the listed areas. Then each area was re-examined, and a new list of complex elements and ideas about them was created to generate a deeper understanding of the artifact as a whole and the meaning of each specific segment of the field mat.

For the third reading, a new spreadsheet containing elements about Ryan's (2014) concept of space was created. A correlation between this spreadsheet and the elements and ideas described in the second reading shaped the data used to explain how the field mat contributes to building space as a meaningful dimension of a robotics game and how it can be used as an artificial design artifact.

(4) Evaluation. The artifact was used as the centerpiece of a workshop for leaders. Afterward, participants were asked to rate the workshop on a Likert scale ranging from 1 (poor experience) to 5 (rich experience) and to leave written comments about it.

(5) Communication. The conclusion section describes the results of this project showing how each activity contributed to the evaluation of

the object as a legitimate educational tool.

4 LOGISTICS FIELD MAT – OBJECTIVES AND DESIGN

One of the objectives of this study was to create a field mat that could be the center of a structured educational environment capable of generating collaborative and competitive experiences for a team-leader workshop.

Although most graphics on the field mat are decorative, some images represent scoring areas where particular objects must be handed over to score points. Other mat parts have specific functions and are described for strategic reasons.

The field mat project in this paper was based on creating a set of activities to practice and develop leadership skills. To connect these skills to the industry theme, five-game strategies based on the logistics of a dry port were developed and applied in a corporate workshop. According to Kradolfer et al. (2014), field mats as game scenarios provide the possibility of skill training that is not directly related to robotics, such as group work, critical thinking, and complex problem-solving.

Figure 1: Deposit containers field.
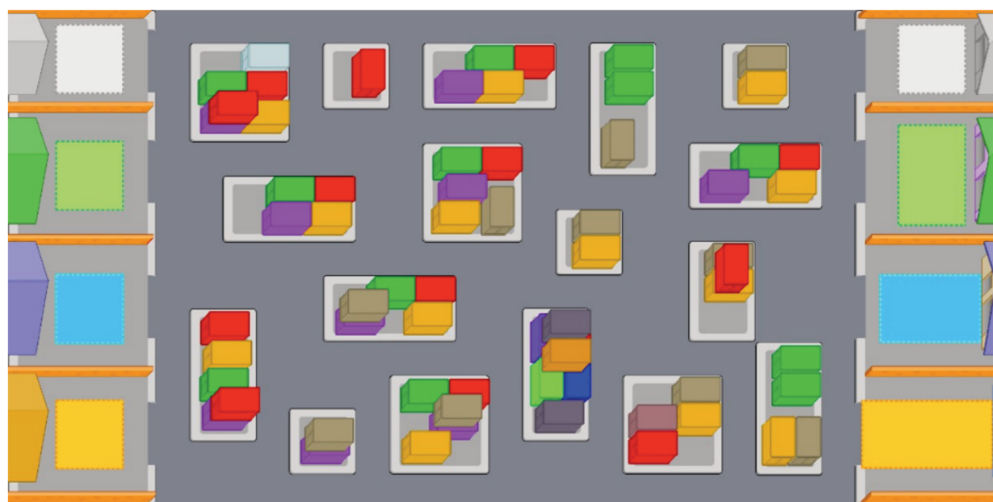
Source: By the authors.

The first three games developed targeted problem solving where groups of leaders competed by having a certain amount of time to
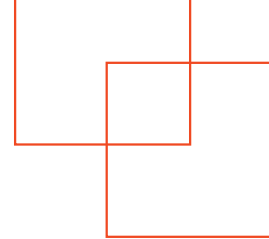
complete challenges that made up the games. The fourth and fifth games were designed as collaborative activities, and teams had to work together to complete specific tasks. Next, a description of each game action area was constructed. The colored areas at the edges of the field mat were labeled as Departure and Arrival Areas, where the imaginary dry port storage docks are located. Within these areas, four points of contact are identified by the colors YELLOW, BLUE, GREEN, and WHITE (Figure 1). These points of contact are locations where players will begin or end most game challenges.
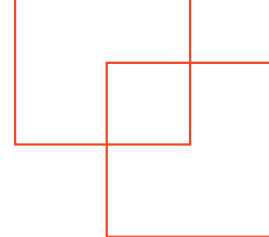
The container areas were labeled as Action Areas and were designed so that players could program their robots to move around, stop, or collect objects in those ground structures. The seventeen sectors on the mat are meant to mimic, in part, the areas in dry ports trucks deposit containers. In addition to these areas, the central corridors represented by asphalt alleys are specific areas where the robots move during some challenges.

With the elements in place, a set of five games were structured in the following format: (1) Teams set up; (2) presentation of the game environment, consisting of the field mat and workstations; (3) introduction of the target missions; (4) execution of the mission, and (5) feedback and awarding of the teams.

5 RESULTS AND DISCUSSIONS

The artifact developed and described in this study is a field mat that competes and cooperates with other media. Bolter and Grusin (1999) use the term remediation to explain how communication media mirror and transform each other. A historical process of spiral iteration is embedded in a media culture that alternates between cooperation and competition and various forms of media. For Bolter and Grusin (1999), all media remediate other media at some point.

The most immediate remediation of the field mat is with a game board. Field mats are designed in computerized environments and printed on a durable paper-like material that can be rolled up or folded for storage, just like a game board. Although the media is different, the production process for the game board and the field mat remains virtually the same. This is also true regarding the design process of both
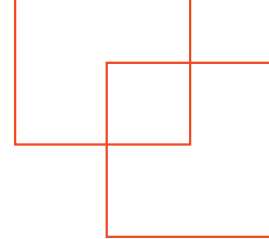
media. While today some talented artists and designers produce field mats, at the time of the first board games, they were also made by skilled craftsmen who crafted the objects with rich detail (NORCIA, 2019).

In terms of gameplay, both media also propose a similar function. While a mat is a themed playing field set up for a robotics competition where robots move around and follow the game rules (SESHAN and SESHAN, 2020 and MAGPILI, 2020), the game board is set up as an imagined space with specific boundaries for players to understand the actions and rules to play the game properly (KINALZIK; HELLER, 2020).

The field mat also remediates fictional maps. Whitehouse (1951) explains that many board games are based on maps and that the first ones were maps with tracks incorporated into them. From this reading, one can see that there is a precise remediation of fictional maps, mainly because both try to represent a space in printed media that is usually placed on a table to be translated and interpreted by its readers. Fictional maps, as well as Field Mats, portray places or locations that don't exist. Artists draw them to depict settings or sites that may or may not be real-world locations.

On the field mat of the container docks, the map-like representation of specific areas of a dry port sets the scene for a narrative that draws the player into a space where there are containers containing goods that must be moved within the space and eventually transported to other regions. All this is seen from an aerial perspective with exaggerations of sizes and dimensions to accommodate all the narrative elements.

Both original and remediated media carry subliminal and even political messages. The field mat described in this paper presents two main messages. The first is a direct communication about how freight transportation happens within the global logistics chain and the role of a dry port in that process. On the other hand, the second message is related to the kind of collaborative work needed to make a dry port work. Kuncoro et al. (2021) argue that collaboration between the various players in a dry port's supply chain is crucial for the business to remain operational and profitable. It is a common understanding that these logistics facilities require complex management among the
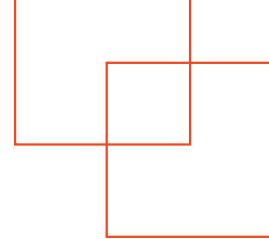
various "players." However, when decisions are shared and planning agreed upon among all players, the supply chain processes become less costly and more profitable. When a group of people works effectively together on a task, they can offer a higher level of productivity, creativity, and adaptability than an individual who could work in isolation (SALAS and BURKE, 2005).

As in themed board games, the field mat of the container docks constructs a Narrative World for people who allow themselves to be engaged in the robotics game. The idea of being in a dry port transports each player into their fictional world filled with cultural knowledge. It also brings up all the connections one has with the cargo logistics chain. During the activity, all these personal Narrative Worlds conflict with each other to form a Narrative Universe.

The combination of a dry port environment and robotics builds a Narrative Universe of personal beliefs that goes beyond robots moving on a field mat with containers to complete challenges and missions. This universe, temporarily constructed, is an environment that not only carries the intersection of stories from the player's Narrative Worlds but also extends the discourse into a much deeper sociological debate about the role of the logistics chain in our modern society. Thoughts and impressions about the supply chain range from the benefits of importing and exporting cargo and supplies to how those goods reach their final destinations. The consequences and repercussions of adequate freight transportation become part of what the players are experiencing within the game. This collection of hypothetical thoughts, dreams, and fantasies generated by the field mat, turns the experience of the narrative world into something concrete as the game and activities unfold and are experienced.

As described earlier, Ryan (2014) points out three other elements of a Narrative Space in addition to the Narrative World and the Narrative Universe. In the field mat, the full extent of its 1.5m x 3.0m can be called a physical board with graphic elements. This socio-historical-geographical environment and the combination of decorative and action elements visually represented on the board form the game setting, the spatial structure, and the story space for the players. The container docks field's mat is where all the game's actions take place.

The start and finish areas represent rest areas on the game board, yet they contain elements that contribute to the theme of the field mat, such as cargo warehouses and covered warehouses.

In addition, the start and finish areas also contain the most critical contact points, represented by the game's YELLOW, BLUE, GREEN, and WHITE squares (Figure 1). Depending on the action the players perform on the mat, these contact points can be just a graphical element, or they can serve as an important station where the robots start or finish their movements. In this way, sometimes a contact point can be invisible to the player's attention, and other times they become an essential part of the scenery as vital elements to the narrated action of each game challenge. The same can happen with the container areas that sometimes play a vital role in the setting and, at other times, are just another graphic object present to compose the image as a whole. Unlike in movies and video games, where the background elements change constantly, the field mat has graphic images printed on its surface. Although static, the combination of graphics, areas, and touchpoints creates different settings for each game mission. Thus, each challenge played on the carpet has its setting with particular characteristics.

The mat is the setting for the five games designed for a leadership training workshop. Although the field mat is where the main action takes place, for gameplay to be complete other supporting areas, make up the narrative space. During the workshop, each group of players had a station attached to the board where the organization of the actions was planned and where the robots were built and programmed to perform the tasks of the challenges. Adjacent tables represented this planning station. These additional spaces make up the spatial frame of the activity as they are secondary environments that promote a constant flow of actions (Figure 2).

Figure 2: Workshop setup
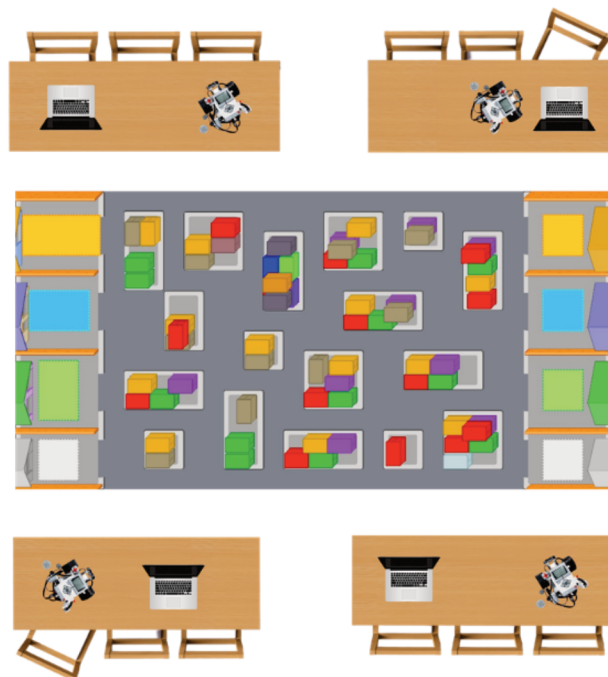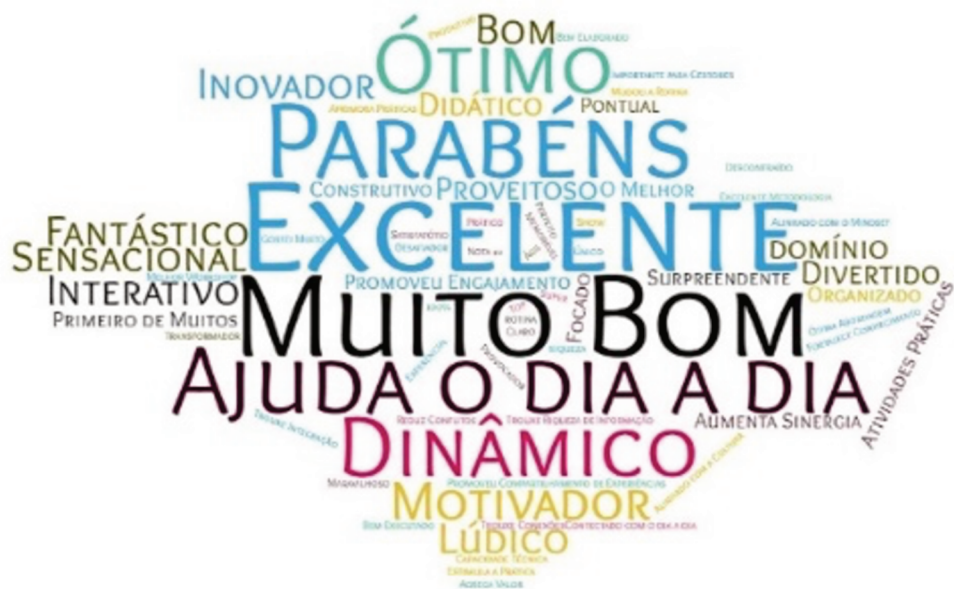

Source: By the authors.

Most of the graphics in the container docks field mat are composed of the representation of sheds and container storage areas that, in real life, would likely have another spatial organization. While the representation of the mat may be unrealistic, the overall composition of the graphics helps to send a message that the narrative space is that of a dry port or distribution center in the format of a land-based intermodal terminal that serves to relieve flow in areas of incoming and outgoing goods connected by roads, railroads or airways. This view of storing containers during the import or export regime until customs clearances is part of the story space that the field mat sends players. Furthermore, each part of the logistics chain can also be considered an element of the story space, as the field mat can trigger personal experiences for one of the players individually, creating the feeling that at some point in the game, they are immersed in another space where the story of the game is happening. This unusual setup becomes part of the plot and story.

Eighty leaders participated in the robotics workshops built within this narrative space. Of these leaders, 62 responded to a questionnaire at the end of the workshop. The results show that 53 out of the 62

participants agreed that the workshop met the objectives of developing teamwork skills, while 60 enjoyed playing games. Of the 62 participants, 61 engaged fully with the robotics games rating the experience as a 9 or 10, and 46 chose to write a comment on the evaluation form. Six comments were criticisms or suggestions for future improvements to the dynamics of the games, while 40 were compliments on the workshop games.

Finally, the comments were examined by a group of five researchers and translated into single words or phrases. These comments were divided into three categories: Perception of Value, Description of Experience, and Expression of Emotion. Expression of Emotion was the category with the most observations, with 50.95% of the words and phrases, followed by Description of Experience with 26.24%, and Perception of Value with 22.81%, as shown in the word cloud (Figure 3).
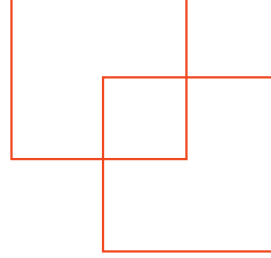
Figure 2: Workshop setup

Source: By the authors.

6 CONCLUSION

This paper presented the process of creating a container depot field mat as a solution for the development of a workshop that promoted

leadership skills for managers of the industrial sector.

Initially, the research space was established using the CaRS methodology. Next, for the design and development stage, two prototypes of a logistics field mat were created and evaluated using the Close Reading method. During the readings, it was demonstrated how a narrative space could create a collaborative gaming environment. The remediation of boards and maps transformed the space into something meaningful to the players, becoming both an area of action and a parallel reality that must be read and interpreted during the gaming experience. Furthermore, during the readings, it was concluded that the theme represented by the graphics and images might be able to convey a subliminal message about the benefits of working together in a collaborative environment within a supply chain.

As a part of the demonstration stage of DSR, an analysis of the Narrative Space indicated that in terms of the setting, the combination of decorative and contact elements, which are visually represented on the mat, can sometimes be just graphics that make up a scene and other times can become action areas which are fundamental parts of the game. The Narrative Space also seems to be extended by the idea of a global logistics chain and the experiences of freight transport, generating a wide story space composed of the mat, additional stations, and personal experiences of the player. Narrative Worlds seemed to further expand the space with a much deeper internal sociological debate about the role of the transportation chain in our modern society and the consequences and repercussions of living in a globalized world. The collection of personal beliefs, thoughts, and impressions about logistical transportation, its benefits, and risks may have created a Narrative Universe in the workshop participants.

As a demonstration of the design object, the field mat was tested with eighty leaders that participated in leadership workshops having the mat as the centerpiece of a series of activities. As a result of this stage, the field mat seemed to be understood as the center of a structured environment, built around a narrative space of free play that, through its ludic characteristics, promotes skills linked to collaborative work. It is suggested that the field mat played a vital role in the robotics game by delimiting the area of action, reinforcing the
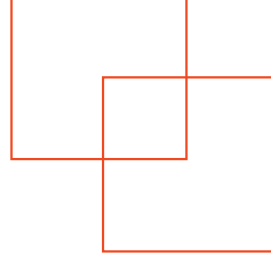
game's narrative, and enabling collaboration among group members and competition between groups. Therefore, the field mat delivers a game setting to foster teamwork combining fun, concentration, and action.

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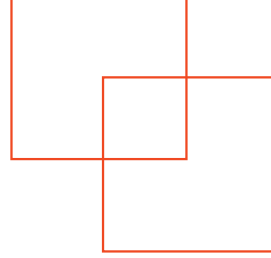
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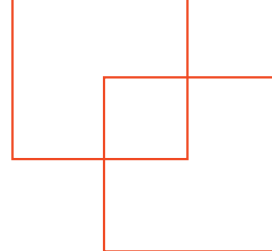
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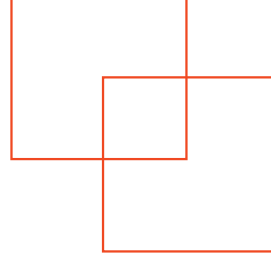
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Alex Paiva

Alex Paiva is a Researcher and Head of Products at Positivo Tecnologia S/A and CITS/PR. He holds a PhD in Design from the Federal University of Paraná and a Master's in Technology from the Federal Technological University of Paraná. He develops research on interactive digital media, focusing on Educational Technology and Serious Games. He is currently responsible for the creation and development of ten technology products including LEGO Education Brasil and BBC Micro:bit.

ORCID: https://orcid.org/0000-0002-1261-956X

Luciane Maria Fadel

Luciane Maria Fadel is a professor in the undergraduate course in Design and in the Graduate Programs in Engineering and Knowledge Management (EGC) at UFSC, and in Design at UFPR. He has a postdoctoral degree in narratives from Simon Fraser University in Canada and University of Porto, Portugal and a PhD in Visual Communication in England. She develops research on interactive digital media, focusing on its construction fundamentals, and on the meaning creation processes in learning environments, games, applications and the web.

ORCID: https://orcid.org/0000-0002-9198-3924